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Mariners Weather Log

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Cover: Three NOAA helicopter pilots sunbathe and fish from the ice covered deck of the NOAA Ship SURVEYOR during one of the rare breaks in the weather while operating in the Bering Sea.

ARTICLES

HINTS TO THE OBSERVER

TIPS TO THE RADIO OFFICER

HURRICANE ALLEY

ON THE EDITOR'S DESK

MARINE WEATHER REVIEW

MARINE WEATHER DIARY

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Mariners Weather Log

HURRICANE ANITA - A NEW ERA IN AIRBORNE RESEARCH

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Flights into hurricane Anita in 1977 by NOAA's new research aircraft marked the beginning of a new era in tropical meteorology research capabilities. Scientists have long recognized the need for more direct quantitative measurements and documentation of the cloud microphysics and temporal and spatial cloud populations in hurricanes in order to improve our understanding and, perhaps, prediction of the formation, motion, and intensity changes in these storms. In addition, these measurements are extremely important for the hurricane modification program. These needs and resultant recommendations from panels of scientists reviewing the hurricane research programs, along with the large potential benefit from a proven technology for reducing the destructive forces of hurricanes, led to the appropriation of $30 million to acquire appropriate aircraft and instrumentation for the research and modification program. This process began in 1973 and finally bore fruit in 1977, when flights into hurricane Anita marked the first major utilization of the nearly complete state-of-the-art aircraft and instrumentation systems now operated by NOAA's Research Facilities Center. This aircraft fleet consists of two P-3 and one C-130 aircraft. Figure 1

Figure 1.--NOAA's new P-3 aircraft with the C-130 in the background.

Figure 2.--Interior of one of NOAA's new P-3 aircraft showing one of the scientific consoles where scientists can interact with onboard computers and have actual data displayed in real time.

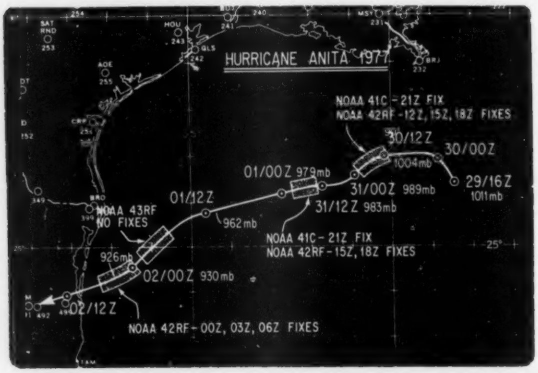

Figure 3.--Storm track for hurricane Anita, August 29 through September 2, 1977.

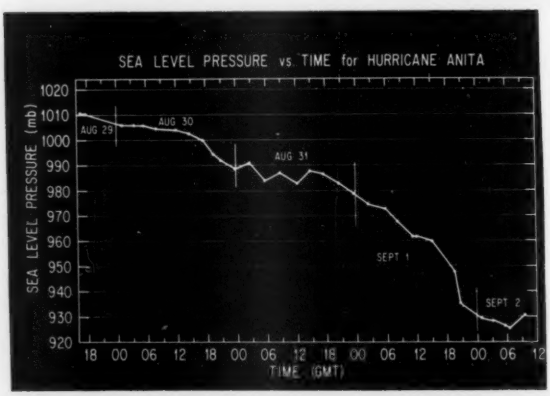

Figure 4.--Profile of the minimum sea-level pressure (MSLP) versus time for hurricane Anita.

Figure 5.--Infrared spectra satellite picture of Anita at 0731 August 30 prior to the storm becoming a hurricane.

shows one of these new P-3 aircraft with the C-130 in the background. Figure 2 shows the interior of the P-3 with one of the several scientific consoles where scientists can interact with the onboard computers and see actual radar and other data displayed in real time on the CRT's. Some examples of these displays for Anita are given later.

The single most important instrumentation improvement and research capability available on the new P-3 aircraft are the digitized-recorded plan position indicator (PPI) and range height indicator (RHI) radar systems. One can now determine and document those temporal and spatial cloud populations so necessary for rigid evaluation of any seeding experiments and for the study and improvement of the basic understanding and prediction of formation, motion, intensity, and scale interactions of the hurricane.

Hurricane Anita was monitored by these special research aircraft on four occasions during its development and traverse, on a generally west-southwestward course, across the Gulf of Mexico. Figure 3 shows the track of Anita; the times and locations of the research flights are indicated by the shaded blocks superimposed upon the storm track. Minimum sea-level pressures (MSLP) are indicated along the storm track. Figure 4 depicts the minimum sea-level pressure versus time. This profile shows a very steady rate of development from midday on August 29 until approximately 1400 on September 1. (All times and dates are GMT.) During the next 12 to 16 hr, the storm deepened rapidly as it approached the coast of Mexico and acquired classical structural characteristics.

STORM STRUCTURE

August 30, 1977--Tropical storm Anita consisted of two distinct areas of deep convection early on August 30. Figure 5 is an IR spectra satellite depiction of a highly asymmetric convective cloud distribution at 0731 on August 30. Nearly all of the deep convection is shown to be south and east of the low-level circulation center. Figure 6 is a visible spectra depiction of the storm at 1800. Again, all of the deep convection is shown to be south and east of the low-level circulation.

The research aircraft first entered the storm at

Figure 6.--Visible spectra satellite picture of tropical storm Anita at 1800 August 30.

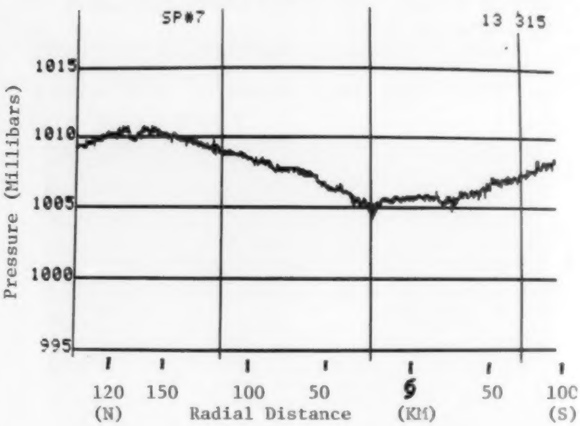

Figure 7. --Computed sea-level pressure north-south profile through Anita for 1303 to 1350 August 30.

approximately 1130 on August 30. Figure 7 shows a profile of the sea-level pressure as extrapolated from a 400-m (1,500 ft) traverse through the storm's center of circulation. Note the very weak pressure gradients.

Figure 7 as well as the remaining figures presented for the aircraft data were produced by direct photography of the CRT displays onboard the aircraft. These profiles are generated as a function of time with the vertical bars being at 15-min intervals; therefore, they are not always centered on the storm for a given pass. Occasionally, a portion of the profile will appear nearly as a mirror image where the aircraft is proceeding outward from the storm center and then turns and heads toward the center of circulation. These areas are easily noted by examining the radial distance legend at the bottom of the figure. (Note the left side of figure 7.) On the C-130 aircraft these data can be relayed to the National Hurricane Center almost instantaneously by means of a data collection platform which utilizes NOAA's GOES-2 satellite data collection capability. The two P-3 aircraft will have this capability next year. (See Mariners Weather Log, November 1977, page 384, for further information.)

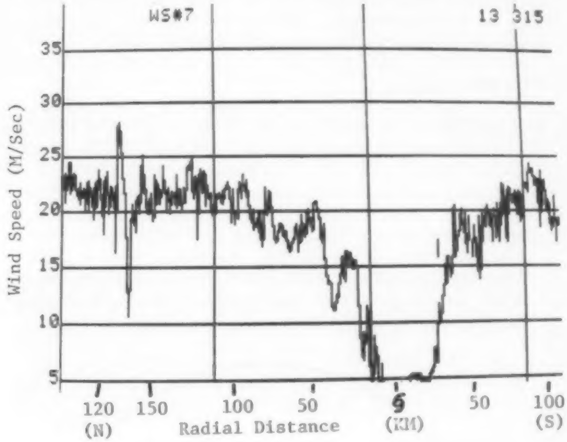

Figure 8. --Actual windspeed profile at 440 m (1,500 ft) corresponding to figure 7.

Figure 8 illustrates the windspeed profile which corresponds to the pressure profile depicted in figure 7. Note the existence of 20 to 25 m/sec (50 kn) winds over an extensive area with no distinct maximum. Several ships were observed from the research aircraft in the area of this developing system and probably experienced these strong winds at considerable distances from the center of the storm. Reports from ships such as these are vital in supplying much needed

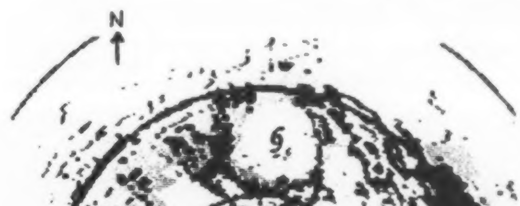

Figure 9. --Plan position indicator (PPI) radar depiction for hurricane Anita at midday August 30. (Center indicated by hurricane symbol.)

ground truth observations. This type of windspeed profile, where the band of maximum windspeeds is broad and some distance from the center of circulation, seems to be characteristic of many weak developing or decaying systems. Hurricane Dora on September 4 and 7, 1964, is an example (Sheets, 1968). These cases all indicate the lack of an established eyewall mechanism.

Figure 9 is a plan position indicator (PPI) depiction of the radar reflectivities for Anita on August 30. The "eye" of the storm was located 112 km (60 mi) north of the aircraft (40 mi - 75 km range markers) at the time this radar presentation was recorded. The convective elements appear quite ragged and weak, although evidence of banding appears in the south and east quadrants of the storm. No radar echoes were observed beyond the weak eyewall echo north and west of the low-level center of circulation, thus confirming the satellite observations.

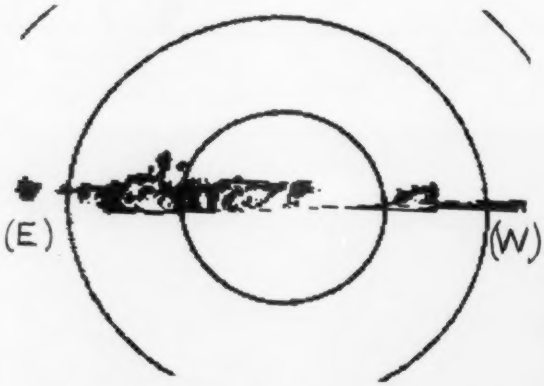

Figure 10.--Range-height indicator (RHI) radar depiction of an east-west vertical cross section through hurricane Anita on August 30. White areas surrounded by black indicate more intense echoes.

Figure 11.--Infrared spectra satellite picture of Anita at 1130 August 31.

Figure 10 is a range height indicator (RHI) radar depiction of the echoes normal to the aircraft track. Range markers are approximately 18.5 km (10 mi). This image was obtained as the aircraft was heading south, having just penetrated the northeastern "eyewall." Again, it is quite evident that little deep convection existed on the western side of the storm and that no substantial eyewall mechanism existed at this time.

August 31, 1977--Figure 11 is an IR spectra satellite depiction of Anita at 1130 on August 31. Two major areas of deep convection are present and appear to have increased in areal extent from the previous day. Figure 12 is a visible spectra satellite depiction of Anita at 1930, which illustrates the much more organized structure of the storm at this time as compared to the previous day. Of considerable significance is the increase in deep convection near the center of the low-level circulation. A highly asymmetric cloud pattern, however, continues to persist, with most of the convection in the southern and eastern portions of the storm.

Figure 13 shows the windspeed profile for a north-south pass through the center of circulation at 440 m (1,500 ft) at about 1430 on August 31. Here we see a

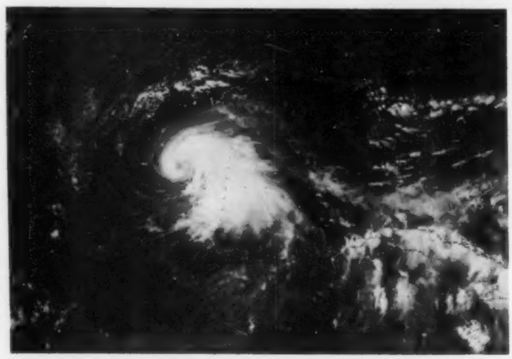

Figure 12.--Visible spectra satellite picture of Anita at 1930 August 31.

more classical windspeed profile with a distinct maximum of nearly 45 m/sec (88 kn) approximately 30 km from the center of circulation. Figure 14 shows a graph of the computed SLP superimposed on the windspeed profile for this same pass. Again, we observe the more classical profiles, although the MSLP is only 989 mb. (Compare figures 13 and 14 to figures 7 and 8 for the previous day.)

Figure 15 is a profile of the windspeed recorded at the same level approximately 1 hr later than for figure 13, but on an east-west pass. The highly asymmetric structure of the storm is quite evident.

September 1 and 2, 1977--Figure 16 illustrates the classical structure of hurricane Anita as observed by satellite at 2300 on September 1. NOAA 42RF, a Research Facility Center P-3 aircraft, was entering the storm at this time. This aircraft remained in the storm for the next 8 hr collecting the best radar data ever recorded in a mature hurricane.

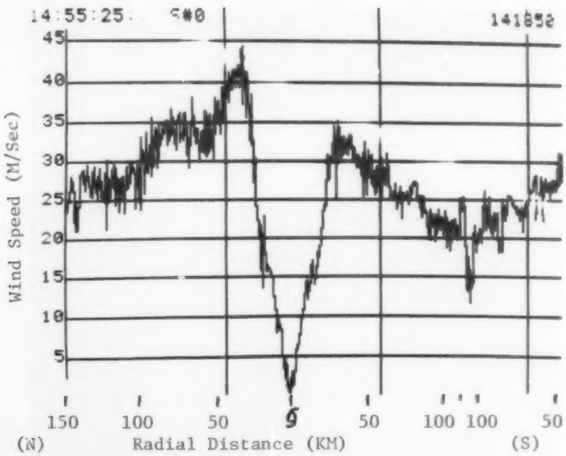

Figure 13.--Actual windspeed north-south profile at 440 m (1,500 ft) through hurricane Anita at 1419 to 1455 August 31.

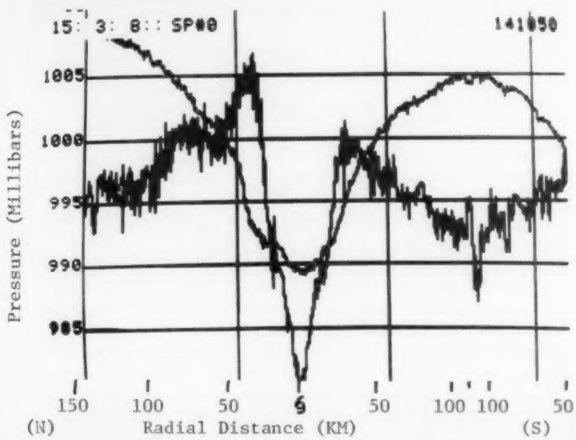

Figure 14.--Computed sea-level pressure profile and windspeed profile corresponding to figure 13.

Figure 17 shows the flight track of NOAA 42RF at about 3,050 m (10,000 ft) for the period 0025 to 0241 September 2 as displayed on the aircraft CRT's. The lines along the track are vectors which represent the wind direction and whose length is proportional to the windspeed.

Figure 18 shows the digitized 5-cm PPI nose radar at the beginning of the final northward pass through the storm center during which the data in figure 21 were recorded. The cellular and intense nature of the eyewall is quite evident. Figure 19 shows a three-picture sequence of the digitized 3-cm RHI radar presentation as the aircraft penetrated the south eyewall. Quite evident is the convective nature of the strong eyewall mechanism, particularly for the east eyewall and the presence of several clouds outside the eyewall which do not extend to the outflow layer and are of the dimen-

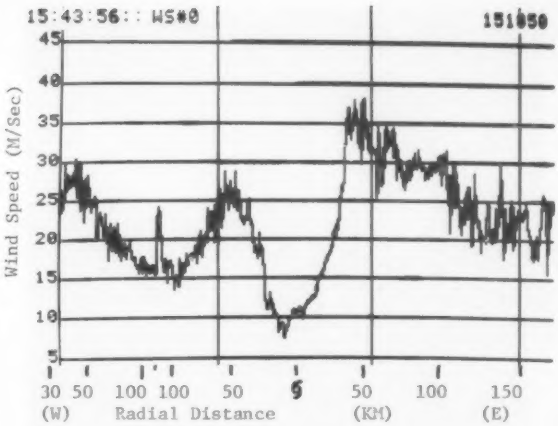

Figure 15.--Actual windspeed east-west profile at 440 m (1,500 ft) through Anita at 1518 to 1605 August 31.

Figure 16.--Visible spectra satellite depiction of Anita at 2300 September 1.

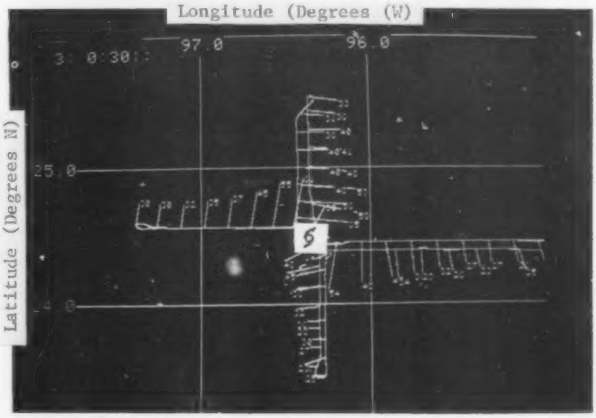

Figure 17.--Flight track of NOAA 42RF (P-3) through Anita at 3,050 m (10,000 ft) from 0025 to 0241 on September 2.

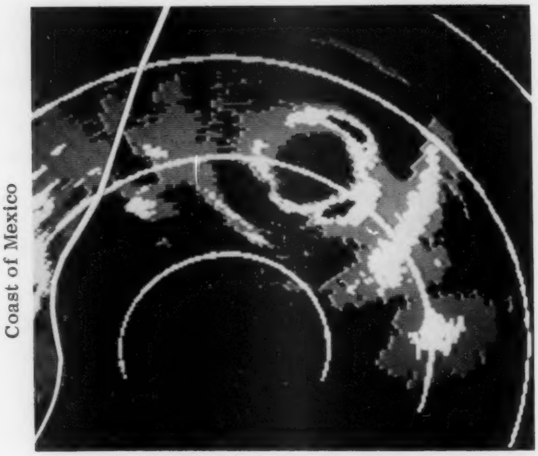

Figure 18.--Digitized 5-cm PPI nose radar depiction of Anita at 0610 September 2.

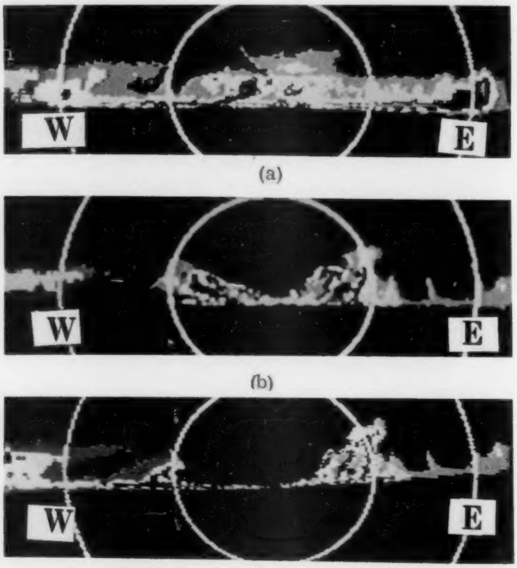

Figure 19.--Digitized 3-cm PPI radar depiction of east-west cross sections through Anita at 0620 September 2 for (a) the south eyewall, (b) the interior edge of the south eyewall, and (c) in the eye.

sional and location characteristics hypothesized for the STORMFURY program (Sheets, 1975).

Figure 20 is a computer-analyzed depiction of the 5-cm lower fuselage digitized radar presentation at 0627 on September 2. Contoured values are in terms of decibel (dB) levels, which can be related to rainfall rates, with maximums exceeding 50 dB. Extensive areas of high precipitation are shown.

Figure 20.--Computer-analyzed depiction of NOAA 42RF digitized 5-cm PPI lower fuselage radar reflectivity levels for Anita at 0627 September 2.

The data illustrated in figures 18 through 20 were recorded when the eye of Anita was only about 50 km off the coast of Mexico, which is shown in the left side of figure 18.

Figure 21 shows the dynamic characteristics of the storm at 3,050 m (10,000 ft) on the final south-north pass through the storm at approximately 0630 on September 2. The windspeed profile is shown in panel (a) with a 5-sec average maximum windspeed of nearly 80 m/sec (155 kn) recorded for the north eyewall. Panel (b) shows the computed SLP profile with a minimum of 926 mb recorded. Panel (c) shows the temperature profile with nearly a 10°C temperature increase in the "eye" at this level as compared to that recorded some 50 km south of the storm center. Panel (d) shows the dew point temperature for this pass with the air nearly saturated within 100 km of the storm center except in the eye itself. An extremely dry and warm region on the northern edge of the eye indicates a vigorous eyewall mechanism with considerable subsidence in this region. Panel (e) shows the 5-sec averaged vertical windspeeds. This profile is superimposed upon the windspeed profile in panel (f). Maximum vertical windspeeds of 13 m/sec (26 kn) upward in the south eyewall and 10 m/sec (20 kn) downward on the interior edge of the north eyewall were recorded. Also, strong vertical motions were recorded in a convective band 150 km north of the storm center.

Figure 22 is an IR spectra satellite depiction of the storm 5 hr later at 1130 on September 2 after the storm moved inland. The intensity of the storm is still quite evident with a well-defined eye and several areas of deep convection around and to the east of the

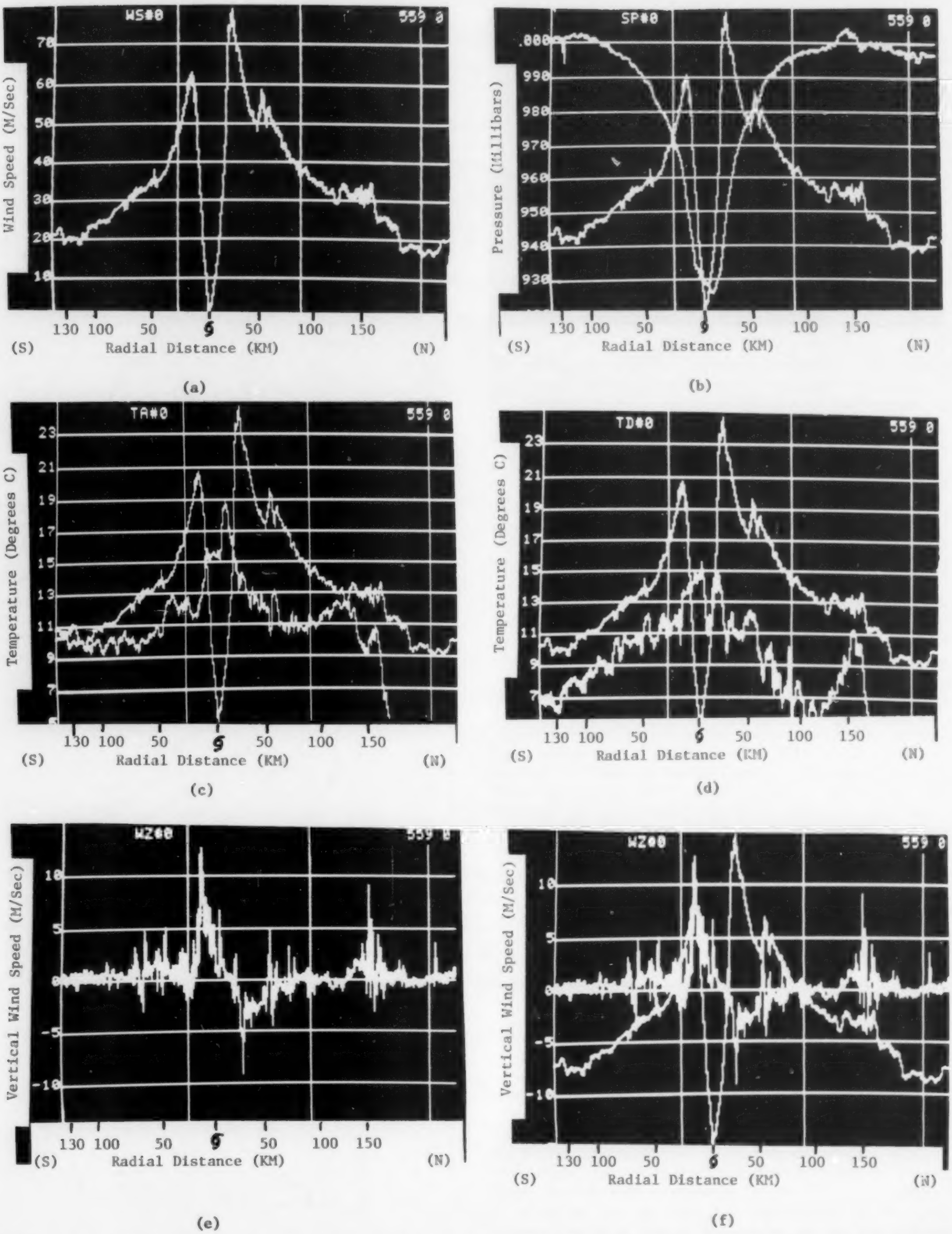

Figure 21.--Profiles of (a) actual windspeed, (b) sea-level pressure and windspeed, (c) temperature and windspeed, (d) dewpoint temperature and windspeed, (e) vertical windspeed, and (f) vertical wind and windspeed for a north-south pass through hurricane Anita from 0559 to 0645 on September 2, 1977.

Figure 22.--Infrared spectra satellite depiction of Anita at 1130 September 2 just after the eye of the storm had moved inland on the coast of Mexico.

center of circulation.

SUMMARY

Hurricane Anita underwent a slow, but continuous intensification from August 29 through about 1400 on September 1. During the next 12 to 18 hr, the storm intensified rapidly to become the second most intense (windspeed and MSLP) hurricane penetrated by NOAA research aircraft. Anita was exceeded by hurricane Inez on September 28, 1966 (Hawkins and Imbembo, 1976). NOAA research aircraft partially documented the structure of Anita throughout much of the developing and mature stages. In addition, excellent oceanographic and satellite data were collected which are being used in several detailed studies of many aspects of this storm's development and structure.

Research aircraft flights into Anita represent the beginning of a new era in our ability to observe and document the convective structure of tropical meteorological phenomena over oceanic areas. Only a few of these capabilities have been discussed in this paper. However, it should be clear from just these few illustrations that the potential for significant increases in our documentation and understanding of the processes generating and maintaining hurricanes is quite large. We look forward to the challenge of effective utilization of these systems.

ACKNOWLEDGMENTS

The author expresses his appreciation to the Research Facilities Center and the National Hurricane and Experimental Meteorology Laboratory staffs and crews which flew this mission and collected these data sets. In addition, special thanks to Jim Brown and Barry Fennell of RFC and David Jorgensen of NHEML for their assistance in the display and production of the illustrations in this paper.

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THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.

Mariners Weather Log

UTILIZATION OF OFFSHORE CURRENTS FOR IMPROVED SHIP EFFICIENCY

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Benjamin Franklin printed the first chart of the Gulf Stream in 1769 to help mariners sail between England and the Americas. Since then such commonly used nautical publications as the Coast Pilot have made recommendations on shipping routes that would take advantage of this swift northward flowing current system (fig. 23). Although the average position of the center of the Gulf Stream has been known since about 1900, changes in its position and strength can occur over periods from days to weeks. In figure 24, the variability in geographic location of the Stream is illustrated. Thus, average currents as presented on charts and atlases may be interesting for general in-

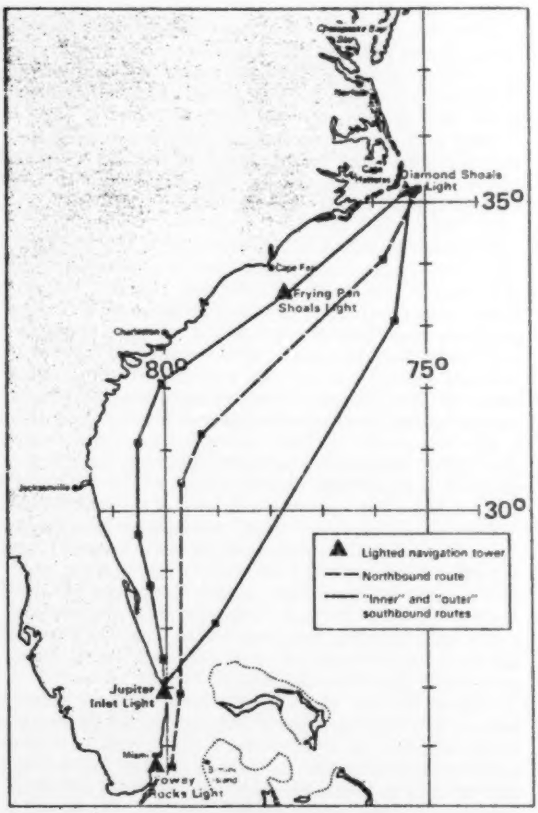

Figure 23.--Routes as suggested by the Coast Pilot (after The Gulf Stream, 1976).

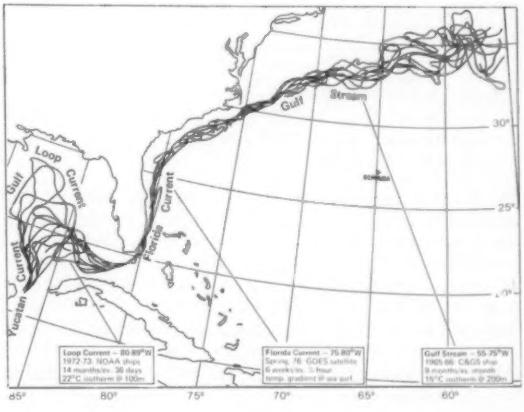

Figure 24.--Variable positions of the Gulf Stream system using different methods to define the coastward edge of the flow (after Maul, 1976).

formation, but the user should realize the large degree of variability that normally is observed. Further, if the mariner is to use this information to his advantage, techniques must be developed to locate such important currents as the Gulf Stream on a regular basis. This topic is the basis of the following discussion, and although given in context of the Gulf Stream, the information presented may be applied to other major ocean current systems.

About a decade ago, oceanographers first realized the position of the Gulf Stream could be reliably located using water temperature at a depth of 200 m. Also, it was found that the maximum surface current (the core) was centered above the location where the temperature was 15°C at 200 m (fig. 25). The core was found to be about 10 mi wide with currents in excess of 2 kn found 30 to 40 mi seaward of this zone. Because the subsurface lines of constant temperature (isotherms) slope at a very steep angle near the Gulf Stream core, a vessel steering along the 15°C isotherm would quickly find increasing temperature seaward of the core and a rapid decrease steering too far west of it. Relatively economical oceanographic methods now exist, such as the expendable bathythermograph (XBT) for measuring subsurface water temperatures. With such information a mariner can judge his location relative to the Gulf Stream core.

Because of the extreme variability in the Gulf Stream, a ship cannot sail miles out of its intended courseline to find the exact Gulf Stream core. The captain must therefore know the approximate path of

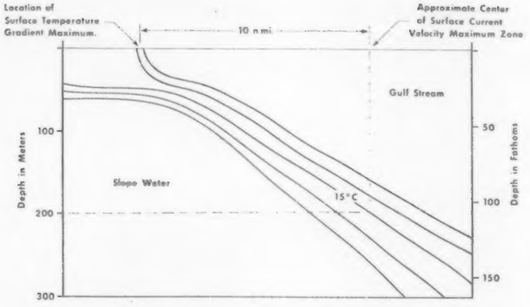

Figure 25. --Schematic water temperature cross section of the Gulf Stream; the view is looking downstream, warm water to the right, cool to the left (after Pashinski and Maul, 1973).

the Stream beforehand, so that he can make a well conceived decision about the vessel's future track. This difficulty can readily be resolved by the use of available satellite data. Satellites carry infrared (IR) scanning devices that regularly yield images of surface sea-water temperatures. The relatively warm waters (dark) of the Gulf Stream stand out clearly from the cooler (gray) nearshore coastal waters in figure 26. Two major problems that arise when using this technique are:

(1) The resolution of the IR scanner is usually not good enough to locate the core with enough accuracy, and

(2) Cloud cover frequently obscures a complete view of the sea surface.

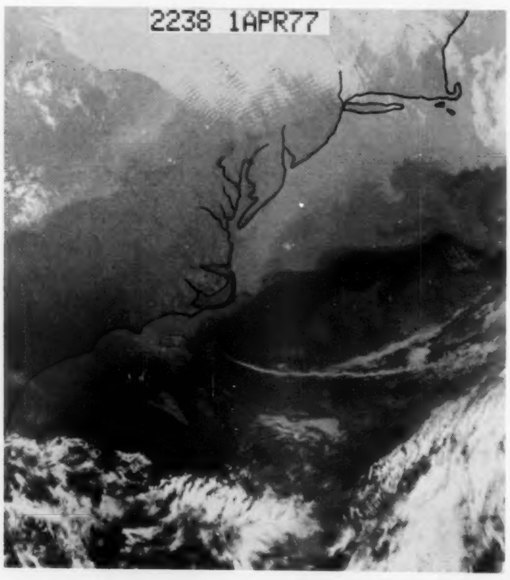

Figure 26.--An infrared image of the U. S. East Coast by NOAA satellite in April 1977. The cooler land masses and cold cloud tops are white, while the warmer coastal waters are gray. The warm Gulf Stream is black.

Equipment now exists to receive data from satellites. Such a receiver can be placed on board a ship for use at sea. This equipment combined with an XBT system could be used to assist present-day Gulf Stream navigation.

Each month a U. S. Coast Guard aircraft equipped with an Airborne Radiation Thermometer (ART) conducts a sea-surface temperature survey of Atlantic and Pacific coastal waters. Chartlets showing the distribution of sea-surface temperatures are prepared after each survey and sent to over 600 users.

During the period between September 1 to 12, 1975, the U. S. Coast Guard Oceanographic Unit conducted an experiment to explore the possibility of using these data to estimate currents in the Gulf Stream. The USCGC EVERGREEN provided ground truth and subsurface Salinity-Temperature-Depth (STD) support for a quasi-synoptic overflight. During this experiment, the Gulf Stream thermal front was located by ART and easily distinguished. The ART front was found to be generally parallel to the core, located by hydrographic data.

The ART, thus, can determine the surface location of the thermal front. This position plus 14 km is the location of the Gulf Stream core. In figure 27 the Gulf Stream surface drift is shown with the location of the Gulf Stream core and thermal front.

This experiment pointed out another available instrument that may be employed to help the mariner locate Gulf Stream currents. This instrument is more sensitive than the satellite IR data.

THE EXXON/NOAA FUEL SAVINGS EXPERIMENT

In 1975 a cooperative fuel savings experiment was carried out jointly by EXXON and NOAA. The program was organized to test how modern Gulf Stream analyses could improve navigation enough to realize significant fuel savings. NOAA analyzed infrared satellite images, located the strong thermal gradient along the Gulf Stream's western boundary, and estimated the axis of maximum current velocities relative to this boundary. EXXON arranged for radio broadcast of the information to their tankers at sea. It was shown that significant fuel savings could be realized by using these oceanographic analyses of the Gulf Stream in everyday navigation. NOAA oceanographers studied Gulf Stream cross sections constructed from STD data and calculated current velocities. The current core was located by temperature measurements at 200m depth. Results showed, however, that the swifter ships' speeds in the Stream failed to outweigh the time and fuel wasted in looking back and forth for the core and in following wide meanders.

Eleven EXXON vessels, steaming from the Gulf of Mexico to East Coast ports and returning, participated in the experiment. Five were instructed to follow usual navigating practices (which used or avoided the Gulf Stream in a general way--see fig. 23); the other six were to use the NOAA data.

Satellite imagery and sea-surface and subsurface temperature reports from ships at sea were analyzed twice a week to locate the Gulf Stream's Western Wall.

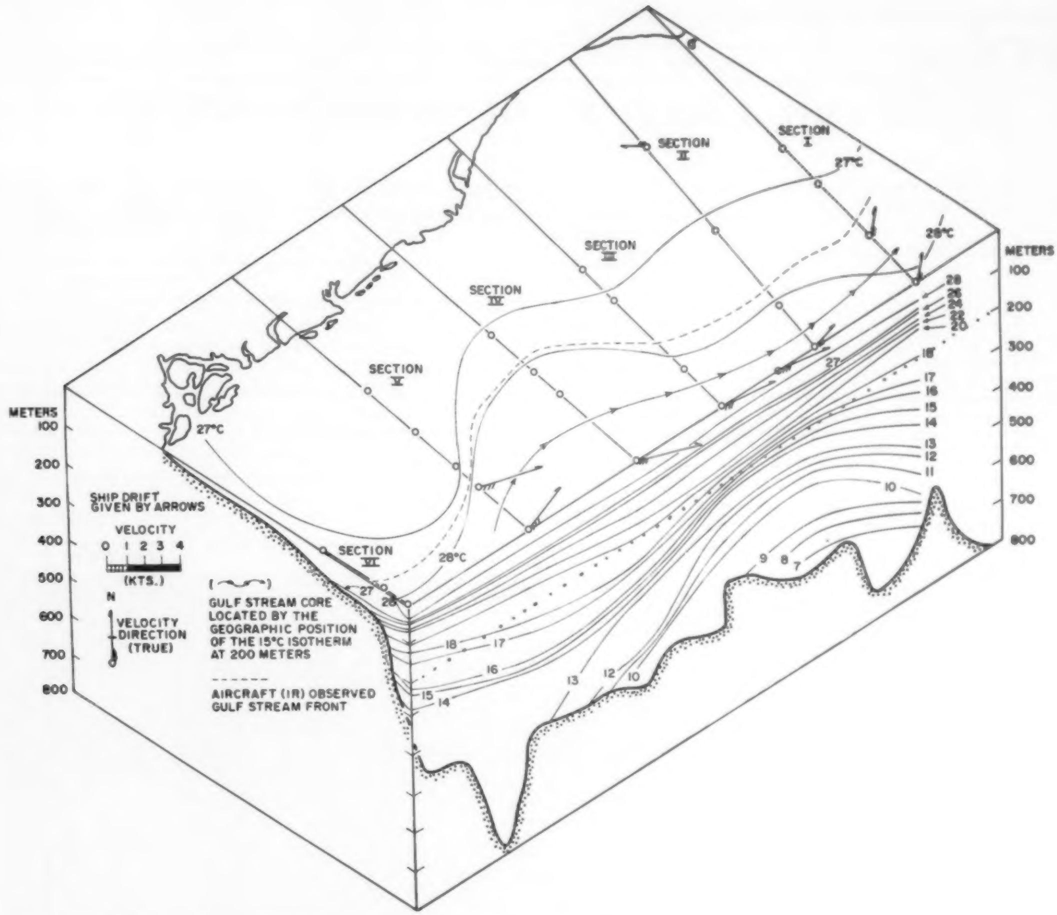

Figure 27.--Drift of the USCGC EVERGREEN, location of the Gulf Stream core (15°C at 200 m), and thermal front during a recent Gulf Stream experiment.

RCA radio broadcast the position--longitude at which the Western Wall crossed each latitude from 27°N to 38°N--to the six EXXON tankers. The ships were instructed to plot these points and shape a northbound course using the maximum current 14 km east of the line whenever the local direction of the Gulf Stream flowed with their general direction. Southbound ships were instructed to steer west of the line or to stay at least 60 mi east to avoid being slowed.

A summary of 108 transits using NOAA data and 82 navigating without showed an average round-trip savings of about 3 percent or 57.55 mi. Table 1 shows calculated fuel savings for the six vessels using NOAA satellite data. EXXON projections for 1976 savings, assuming a total of 15 tankers all navigating by satellite data, amounted to 31,523 barrels. Using a cost of $11.50/barrel, the EXXON report estimated potential annual fuel savings at about $360,000.

CONCLUSION

Use of satellite-derived Gulf Stream positions is now standard navigating procedure for all ships of the EXXON Company. Similar practices for all coastwise traffic of the U. S. Merchant Marine would result in significant conservation of U. S. fuel resources. A revised version of the Gulf Stream Wall Bulletin is now updated three times weekly by NOAA; it is available to all listeners following the Marine Weather broadcasts on two Coast Guard radio stations (see table 2). The bulletin is given in plain language and includes all significant turning points marking the western boundary line of the Gulf Stream.

A similar product is now being tested for Gulf of Mexico navigation. A clockwise flow of warm water from the Yucatan Straits, around the Gulf, and out through the Florida Straits is quite coherent and strong. The coastwise edge of warm water in this so-called Loop Current is marked by a thermal contrast which is great enough in the cold winter months to show in satellite infrared imagery. NOAA personnel at the Miami Satellite Field Services Station are producing a Loop Current analysis (November to

Table 1.--Fuel savings using satellite data

Vessel	Ave. Speed	Barrels/Hr.	Trips	Barrels Saved*
BATON ROUGE	16.7	27.0	23	2,140
NEW ORLEANS	16.2	26.8	26	2,475
BOSTON	15.2	23.3	23	2,029
LEXINGTON	17.5	29.6	22	2,142
JAMESTOWN	17.7	28.3	26	2,392
HUNTINGTON	14.3	16.7	20	1,344
				12,522 Total**

Additional savings were calculated as follows:

Time	Additional Vessels	Trips	Barrels Saved
Sep.-Dec., 1975	5	121	10,619
Early 1976	4	97	8,382
–Projected–			
All 1976	15	362	31,523†

*All estimates based on average roundtrip saving of 57.55 nm.
**Total barrels of fuel saved by 6 ships in 140 transits during 7 months (Feb.-Aug., 1975) using NOAA satellite data.
† @ $11.50/barrel $360,000.

Table 2.--Radio broadcasts of Gulf Stream analysis

Station	Greenwich Mean Times (Daily Transmissions)	Frequencies kHz
Radiotelegraph (CW)		
Portsmouth, Va. (NMN)	0120, 1620	448
Miami, Fla. (NMA)	0100, 1600	440
Radiotelephone (voice)		
Portsmouth, Va. (NMN)	1600, 2200	6521.8 8760.8 13144
Radiofacsimile		
Norfolk, Va. (NAM)	1305 (Thurs. only)	3357 4975 8080 10865 16410 20015

March) for improved Gulf of Mexico navigation using the current. Comments are currently being solicited from all merchant vessels plying Gulf of Mexico waters.

This brief report deals with but one example by which today's knowledge of the oceans can aid the mariner. Many other useful tools are available, waiting only for the oceanographer and mariner to start working together.

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Mariners Weather Log

AN EXAMPLE OF SHIPBOARD AIR TEMPERATURE ERRORS

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Accurate reports of air temperature over the oceans are needed for forecasts and climatological studies. Unfortunately, temperature measurements aboard ship are subject to a number of errors, and the data may not be representative of conditions in the marine atmosphere near the surface. Some measurements in March 1974 aboard the NOAA ship OCEANOGRAPHER (fig. 28) off northwest Africa permit an examination of some of the sources of error; they also add support to the measurement practices recommended by the National Weather Service.

The data examined here were obtained during an oceanographic study for 3 days when the ship was anchored (bow into the wind) taking hourly hydrocasts and special meteorological measurements from sensors mounted on a boom that projected forward of the bow (fig. 29). During this study, wet and dry bulb temperatures were recorded on the hour (generally within at least 5 min of that time) by quartermasters on the bridge and also on an upper deck near the stern by the technicians who took the hydrocasts. Observations on the bridge were made with thermometers

Figure 28.--NOAA ship OCEANOGRAPHER.

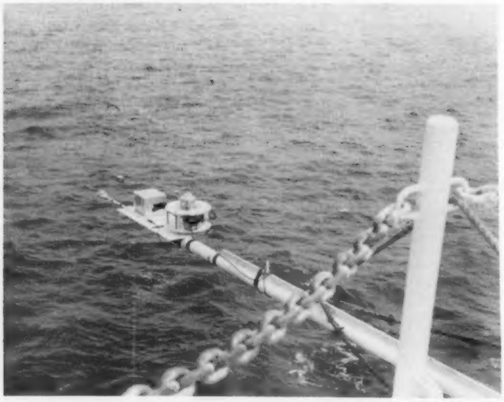


Figure 29.--The boom where the sensors were located mounted on the bow of the OCEANOGRAPHER.

mounted in a ventilated box attached to the bulkhead; the thermometers were generally only read to the nearest 0.5°F (0.3°C). This instrument system frequently did not have direct exposure to the wind. Measurements near the stern were made with a sling psychrometer; the wick was wetted just prior to each use, the thermometers were read to the nearest 0.1°C, and the technicians were cautioned to expose the psychrometer to the wind.

Comparisons between air temperatures obtained from the bridge and stern showed large and systematic differences. Values from near the stern were generally greater than those from the bridge; differences during midday were frequently greater than 1°C but were not so marked at night. For the 3-day period March 24 to 26, 1974, the mean hourly air temperature at the bridge was 0.3°C lower than from that at the stern. The corrected data from a thermistor mounted on the boom forward of the bow (facing directly into the wind) gave mean results that were 0.2°C lower than mean values at the bridge. Thus, this comparison suggests that 3-day mean air temperatures measured at the bridge and near the stern were 0.2°C and 0.5°C too high respectively. Winds during this 3-day period were light (generally less than 10 kn), which would have tended to enhance heating of the air near the ship. (A similar comparison between relative humidity determined from measurements at the bridge and stern did not reveal systematic differences, but data are not available to determine if absolute errors exist in both data sets.)

It should be noted that the three sensors used were not at the same height; elevations above the sea surface varied between about 7 and 15 m, with the location near the stern being lowest and the bridge site the highest. If vertical gradients of air temperature accounted for the observed mean differences, however, the bow sensor would have been located in a persistent thermal minimum between the other two sites. Such a situation seems quite unlikely because the mean air-sea temperature difference (based on values at the bow) was 0.0°C, and the large differences in the air temperature measurements tend to disappear at night.

Although it is difficult to assess the causes of the temperature errors with certainty, it seems likely that the smaller systematic errors in the bridge measurements were caused by less heating of the atmosphere by the ship in this location and perhaps also because the thermometers in the ventilated box were not heated by solar radiation. Even though the sling psychrometer is a more precise instrument than the system used on the bridge, the air near the stern was probably heated more by the stack (and the ship in general) than it was forward, and the thermometers may have been more affected by radiative heating during daylight hours than the enclosed ones on the bridge. Both sets of measurements, however, appear to have been affected somewhat by heating from the ship. An intercomparison of shipboard measurements with sensors on a buoy during the GARP Atlantic Tropical Experiment in 1974 showed systematic biases in the measurements from some ships even greater than those reported here. This emphasizes the need to make temperature measurements in a well-exposed, windward location; on ships underway, this usually can be accomplished conveniently from one of the bridge wings.

Although an occasional error of 0.5°C or greater can be tolerated in a data base, errors of this magnitude in mean data would cause serious problems. For example, evaporation from the ocean is often a large and variable heat flux which is usually computed from measurements of windspeed and the vapor pressure difference between the sea and air. For the environmental conditions observed during this study, it was estimated that use of a mean air temperature 0.5°C too high would cause the computed evaporative flux to be about 20 percent too low. These and other computations are quite sensitive to the quality of the data used.

Mariners Weather Log

COMMSTATION PORTSMOUTH

L. V. Dorrian
U. S. Coast Guard
Chesapeake, Va.

NMN NMN NMN // DE // 5LKL 5 LKL OBS QAA 389 K// 5LKL DE NMN R UP QRY AS

And so it goes on repeated some 250 times a day, commercial vessels plying the Atlantic calling the familiar NMN. But NMN has changed. The old radio station at Pungo, Va., for nearly 2 decades has been replaced by a modern communications station (fig. 30) with some 85 officers, men, and women assigned. The new COMMSTA PORTSMOUTH has been provided an advanced and enlarged capability for command and control of Coast Guard forces in the Atlantic, both afloat and airborne, for maritime safety and service to other government agencies.

The need for a new Coast Guard long-range communications facility to support the Atlantic Maritime Region was recognized for over a decade. Planning started at Coast Guard Headquarters in 1968. A contract was issued to the Institute for Telecommunications Sciences (ITS), Department of Commerce, to study eight feasible sites and to recommend the best three. Based on personal visits and extensive propagation computer analysis, ITS ranked the sites Northwest Virginia, Sugar Grove, W. Va., and La Plata, Md. A Coast Guard economic analysis concluded that the Northwest Virginia site was the cost-effective choice. Further analysis by ITS concluded that with the selection of Northwest, radio operations could be terminated at Radio Washington (NMH), Pungo (old NMN), New York (NMY) and Jacksonville (NMV) without a decrease in operational effectiveness or service to the Atlantic.

The U. S. Coast Guard Commandant formally established the concept of an Atlantic Area Communications System in 1972 with system control at Portsmouth, Va.,

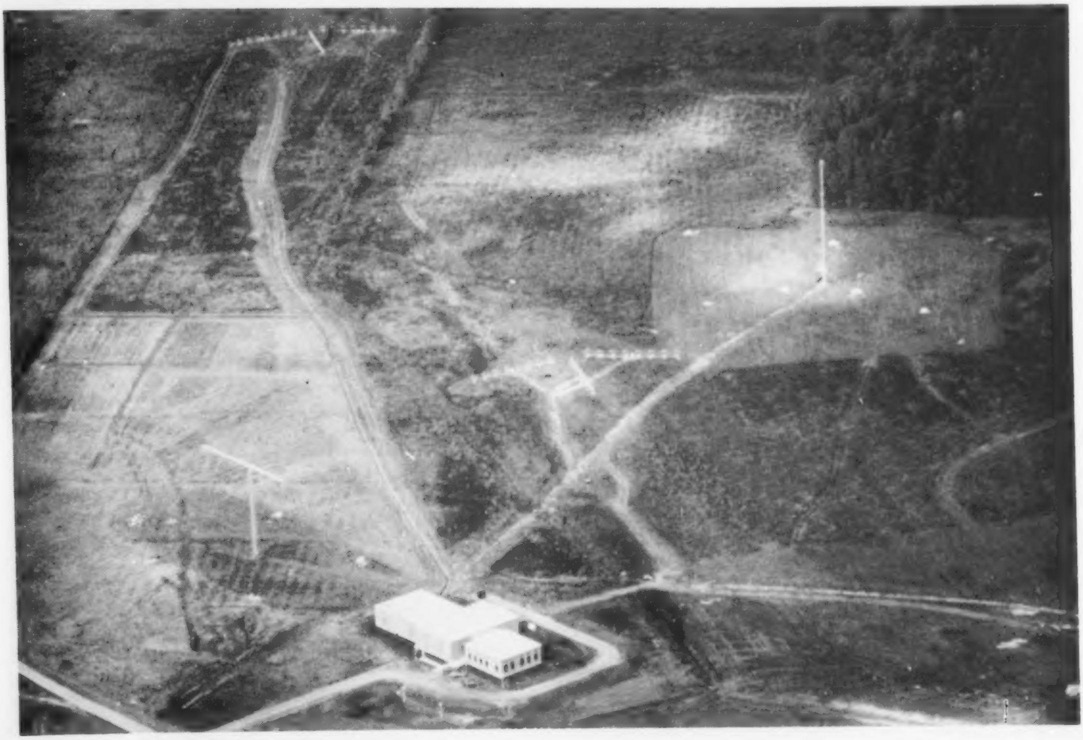


Figure 30.--The new Main Receiver Building at COMMSTA PORTSMOUTH in Chesapeake, Va.

Figure 31.--Main operations center at Coast Guard COMMSTA PORTSMOUTH.

alternate control at Boston, and with Miami, New Orleans, and San Juan comprising the remainder of the system. To support this concept a new station was required at Portsmouth. After Congressional budgetary approval in 1973, construction began in mid-1974.

COMMSTA PORTSMOUTH was commissioned on May 28, 1976, and began operations on June 17. Operations/Administrative functions are at Northwest, with the transmitting functions some 17 mi to the northeast at Pungo. A tenant at Naval Security Group Activity, Northwest is located some 35 mi southeast of Portsmouth, where the Coast Guard has some 300 acres within the Navy's 4,800 acres. Approximately 200 acres are used for the receiving antennas and the Operations/Administration building, with the remaining 100 acres for 36 housing units and a 48-man/woman Bachelor Enlisted Quarters. Although independent, the Station's support requirements are integrated with the Navy's: a common galley, medical and dental facility, and special services facilities (gymnasium, pool, club, exchange, gas station, picnic grounds, chapel, and movie theater).

The Operations/Administration building has about 13,000 sq ft of floor space of which 25 percent is allocated to actual receive operations and the remainder to office space, store rooms, mechanical rooms, and electronic repair shops. The heart of the Station is the Operations Center (fig. 31) with some 12 operating positions. Modular in design, the individual positions (12 ft by 12 ft room with console) have been equipped with specific operating functions in mind.

Figure 32.--The all-mode operating console.

However, most are capable of all-mode operation (voice, RATT, CW) (fig. 32). Each operating console is capable of controlling automatically four transmitters and associated antennas.

The electronics system was designed and installed by Collins Radio Company. Forty-eight receivers (40 651S-1A tunable receivers and 8 R-1735 fixed receivers) are available. Most positions have four tunable receivers. Model 37 teletypewriters are used throughout the Station. Communications Security is provided by six cryptologically-covered teletype circuits. Six simultaneous phone patches can be conducted. Direct AUTODIN interface is provided through a microwave link to NAVCAMSLANT Norfolk. A direct landline-covered circuit to COMLANTAREA is maintained at all times. The remaining four covered full-duplex teletype circuits are used for ship-shore terminations (two active, two on call). The Coast Guard's Search and Rescue circuit for the Atlantic, the National Weather Service circuit, and the Fifth Coast Guard District teletype circuit comprise the remaining record landlines. The receiving antenna system consists of one omni-directional antenna for MF and HF, two space diversity triple Hermes Aperiodic loop arrays, one rotatable log periodic antenna and one omni-directional high-angle HF antenna primarily for air/ground operations. Radio operators cau automatically, through the computer processor, select and/or change transmit frequency, antenna, mode and power, and receive antenna selection. Video Display Units (VDU) in each operating position provide the individual operator with the Station status; all transmitters show antenna, frequency, power and mode, and any other general information desired. The silent periods 500 KHz and 2182 KHz and time are also displayed on the VDU.

At Pungo on 225 acres a new transmitter building and antennas have been constructed (fig. 33). The old NMN operations building sits vacant, a reminder of the past. The new transmitter building with 6,000 sq ft of floor space consists of a transmitter room, transmitter control and antenna matrix room, lounge, kitchenette, mechanical room, store rooms, and repair shops. Fifteen fully synthesized 10 KW HF Collins transmitters (URG-IIs) and three 2 KW MF (AN/FRT-89s) are installed. Wiring, space and control equipment is available for an additional five HG transmitters and one MF transmitter. The heart of the system is a PDP-11 computer for system control, status fault detection, isolation, and correction. High-level RF antenna patching is accomplished through a 20 by 30 automatic delta matrix, the largest known to be in existence. Seventeen antennas are available for transmitting: six omni-directional, eight horizontally polarized directional log periodic, one rotatable 4-30 MHz, and two base-loaded transmitting MF towers. One omni-directional antenna is triplexed for broadcast functions. A 235-ft microwave tower links Pungo to Northwest. No other control lines exist between the two sites.

With these facilities the Station fulfills the following

Figure 33.--Transmitting site at Pungo, Va.

Figure 34.--The operator receiving HF AMVER CW information.

operational requirements:

Communications Watch Officer (CWO) - System Control and Coordination
Facilities Controller/System Control Circuits Atlantic Area
Landlines
500 KHz Distress
8 MHz AMVER
12 MHz AMVER
16 MHz AMVER (day only)
Air-Ground (voice and RATT)
Ship/Shore 1
Ship/Shore 2
Broadcast
Ship/Shore 3 (spare)

Each of the HF AMVER positions (8, 12, and 16 MHz) has been equipped with CW sending machines in lieu of mechanical call tapes (fig. 34). The CW sending machines are solid state, dual 1,024-bit memories for automatic transmission of CW upon demand at variable speed in either 256- or 512-bit segments.

During January 1977 27,000 messages were processed with a daily high of 1,100. Approximately 7,000 RATT messages were sent and received with 99 percent cryptologically covered. Nearly 250 phone patches were processed with a daily high of 20. Air-ground communications were provided for 300 separate Coast Guard aircraft sorties. These figures have been steadily increasing since the station became operational in late spring 1976. COMMSTA PORTSMOUTH now receives more AMVERs and METEOs than any other Coast Guard radio facility, approximately 7,000/mo. We believe this to be a function of our modern equipment, improved capabilities, and the strong desire to prove that COMMSTA PORTSMOUTH is the best communications facility in the Coast Guard.

A key question of the mariner in the Atlantic Maritime Region is, "How does this affect me?" To begin with, basic service in terms of reliability and range of effective MF/HF communications has been significantly improved and expanded over previous Coast Guard capability. More services are available: voice in addition to CW, expanded HF weather broadcasts, and so forth. Through this Station, the Coast Guard will be able to provide required medium- and high-frequency radio telecommunications for the Atlantic through 1990. With the gradual shift to satellite techniques, fewer coast stations will be required. Further reductions in Coast Guard long-range terrestrial radio facilities are anticipated, particularly in the Gulf and Caribbean region.

While change goes on, COMMSTA PORTSMOUTH is a commitment by the Coast Guard to maritime safety in the Atlantic.

Hints to the Observer

WIND DIRECTION

Reporting accurate wind direction and speed is probably one of the most difficult meteorological observations made by the mariner, particularly if he has to estimate rather than read a sensor. He has to determine the speed and direction of a moving air mass, which is not steady from a moving platform. The relative speeds and directions may differ radically, and the apparent wind must be adjusted to obtain the true wind.

Wind directions are to be reported to the nearest 10 degrees of the compass. A recent summary of wind directions reported from U. S. cooperating ships using 31,067 observations was prepared by Robert G. Quayle of the National Climatic Center, Asheville, N. C. The study indicated a definite bias toward the 16 points of the compass (fig. 35), and especially the 8 principal points. The bias may be influenced by the prominence of the principal points printed on the compass.

A similar study by Quayle on the direction of swell waves (Mariners Weather Log, Sept. 1977) indicated the same bias tendency toward the 8 and 16 principal points.

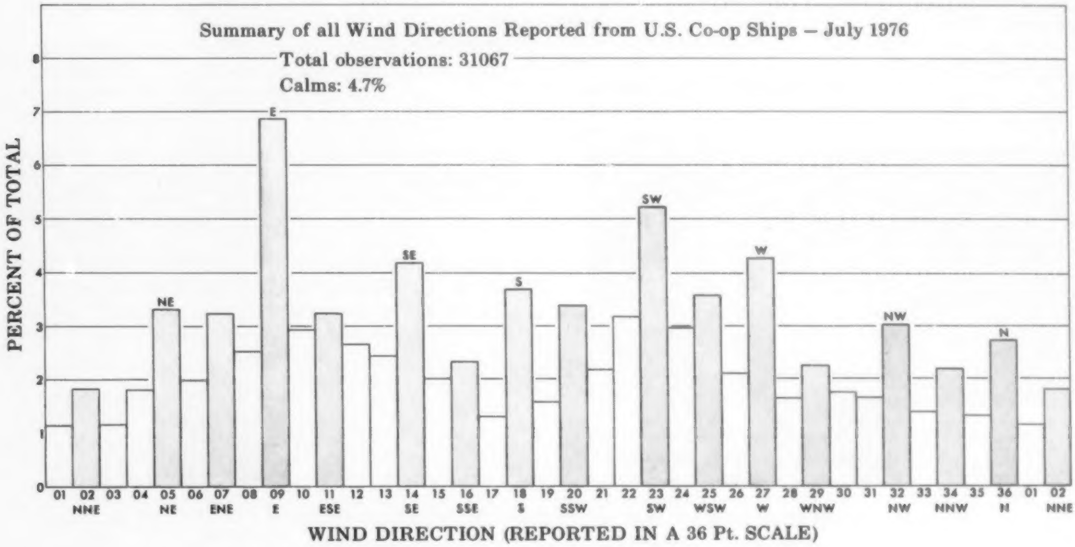


Figure 35.--Frequency distribution of wind direction reports shows bias toward 16 points.

APPRECIATION OF COOPERATION

We appreciate your good responses to the World Meteorological Organization's questionnaire on transmission of ships' weather reports. We received over 400 completed questionnaires.

The answers to the questions varied, but there was considerable agreement that the U. S. shore stations were doing a good job. There was considerable praise for Coast Guard shore stations. There were many excellent suggestions on the questionnaires, which we have since sent to the WMO for detailed analysis. WMO's findings will be passed on to you as soon as they are available.

Tips to the Radio Officer

Thomas H. Reppert
National Weather Service, NOAA
Silver Spring, Md.

The latest edition of Worldwide Marine Weather Broadcasts (July 1977) has been distributed to radio officers on vessels in the Cooperative Ship Program. It is also available from the Superintendent of Documents, U.S. Government Printing Office, Wash., DC 20402.

In addition to the U.S. Coast Guard radiotelephone frequency changes listed in the Mariners Weather Log, November 1977, the Bell System (AT&T) has announced that their High-Seas Radiotelephone Service was changed to the following frequencies effective 11:59 p.m. on January 1, 1978.

	Coast Station Transmit (Carrier) kHz	Ship Station Transmit (Carrier) kHz
KMI Inverness, Calif.	4357.4	4063.0
	4403.9	4109.5
	4407.0	4112.6
	8728.2	8204.3
	8743.7	8219.8
	8759.2	8235.3
	8784.0	8260.1
	13100.8	12330.0
	13103.9	12333.1
	13107.0	12336.2
	13187.6	12416.8
	13190.7	12419.9
	17236.0	16463.1
	17239.1	16466.2
	17279.4	16506.5
	17304.2	16531.3
	22636.3	22040.3
	22664.2	22068.2
	22679.7	22083.7
	22704.5	22108.5
WOM Ft. Lauderdale, Fla.	4363.6	4069.2
	4391.5	4097.1
	4407.0	4112.6
	4425.6	4131.2
	8722.0	8198.1
	8731.3	8207.4
	8746.8	8222.9
	8793.3	8269.4
	8811.9	8288.0
	13116.3	12345.5
	13122.5	12351.7
	13125.6	12354.8
	13144.2	12373.4
	13169.0	12398.2
	17232.9	16460.0
	17257.7	16484.8
	17260.8	16487.9
	17263.9	16491.0
	22639.4	22043.4
	22642.5	22046.5
	22661.1	22065.1
WOO Manahawkin, N.J.	4385.3	4090.9
	4388.4	4094.0
	4403.9	4109.5
	4422.5	4128.1
	8740.6	8216.7
	8749.9	8226.0
	8762.3	8238.4
	8796.4	8272.5
	13107.0	12336.2
	13128.7	12357.9
	13131.8	12361.0
	13184.5	12413.7
	13190.7	12419.9
	17245.3	16472.4
	17291.8	16518.9
	17310.4	16537.5
	17325.9	16553.0
	22596.0	22000.0
	22608.4	22012.4
	22623.9	22027.9
	22704.5	22108.5

In order to ensure service continuity, AT&T will continue to operate on selected frequencies now in use for a limited period of time. This interim arrangement will continue until 11:59 p.m., March 31, 1978. After this all AT&T stations will operate on the new frequencies.

The selected frequencies for the interim period are:

	Coast Station Transmit (Carrier) kHz	Ship Station Transmit (Carrier) kHz
KMI Inverness, Calif.	4422.2	4123.6
	8738.4	8204.4

	Coast Station Transmit (Carrier) kHz	Ship Station Transmit (Carrier) kHz
	8735.2	8201.2
	13161.5	12382.5
	17307.5	16512.5
WOM Ft. Lauderdale, Fla.	4422.2	4123.6
	4428.6	4130.0
	8796.0	8262.0

	Coast Station Transmit (Carrier) kHz	Ship Station Transmit (Carrier) kHz
	13140.5	12361.5
	17286.5	16491.5
WOO Manahawkin, N.J.	4403.0	4104.4
	8754.4	8220.4
	13172.0	12393.0
	17321.5	16526.5
	22657.0	22031.5

Hurricane Alley

Dick DeAngelis
Environmental Data Service, NOAA
Washington, D.C.

There was no tropical cyclone activity in the Southern Hemisphere during September and October. This is not unusual. The average is about one tropical storm every 2 yr.

NORTH INDIAN OCEAN - SEPTEMBER AND OCTOBER

It was not until late October that the first storm of the fall season formed in these seas, just west of Nicobar Island (fig. 36). Moving west-northwestward,

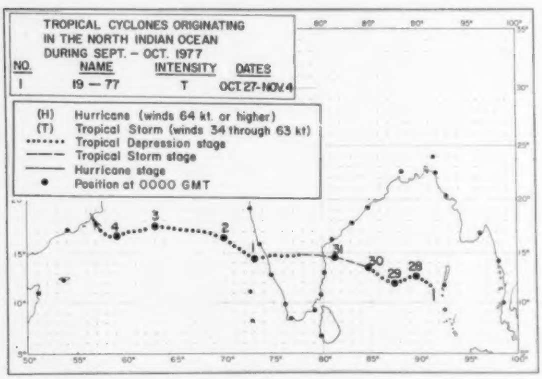


Figure 36.--North Indian Ocean tropical cyclone track October 1977.

the depression intensified to tropical-storm strength by the 30th. Maximum winds climbed to 50 kn just before the storm moved ashore between Madras and Masulipatam. This storm was a harbinger of the events to follow in 3 weeks. The system moved across India, weakening overland, and into the Arabian Sea on November 1 as a tropical depression. For the next several days, it followed a westward course but could not regain storm intensity (fig. 37).

Figure 37.--Early on the 4th the depression approaches Muscat and Oman, but it dissipated before making landfall.

NOVEMBER HURRICANE TWINS

These two tropical cyclones (fig. 38) would normally be described in the next issue of the Log.

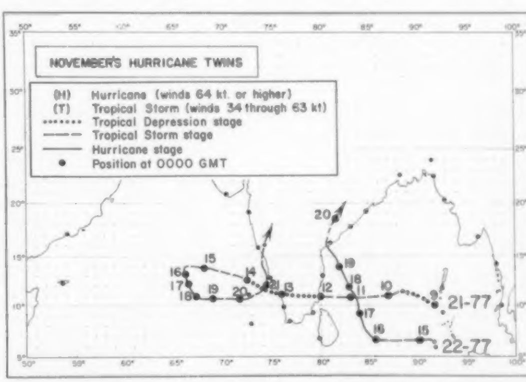


Figure 38.--Tracks of the two November storms that devastated India.

Figure 39. --Seven survivors of a storm surge which destroyed their coastal village of Divi Taluk run toward the helicopter dropping food on the 24th. Wide World Photo.

Figure 40.--This village near Tiruchirappalli was devastated by the floods. Indian troops mingle with villagers after the storm on the 22d. Wide World Photo.

However, the devastation wrought by these systems makes immediate coverage imperative.

"Hell on earth." This was the description of the aftermath of the two tropical cyclones that devastated southern India during November. "Thousands of bloated human corpses and animal carcasses were strewn about creating an acrid stench. In some villages the living are struggling for survival and have no time to attend to the dead! They are so shocked they have ceased to cry." (figs. 39 and 40)

For 10 days the southern peninsula of India was besieged by gales, torrential rains, severe flooding, and a devastating storm surge. The first tropical cyclone brought gales and heavy rains to both coasts of India. It reached peak intensity of about 85 kn out at sea from the 17th through the 19th (fig. 41). The

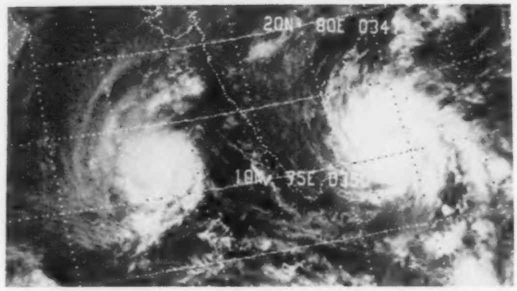


Figure 41.--On the 17th the two devastating hurricanes are near peak intensity.

second system, which formed a week later and less than 300 mi farther south, became one of the most intense storms in Indian Ocean history. Winds estimated at 135 kn roared around the center on the 18th and 19th as the storm approached and crossed the coast near Masulipatam. With it was a 19-ft wall of water commonly called a "tidal wave," but more properly known as a storm surge. This surge extended along 50 mi of coast battering everything in its path and then moved inland at distances up to 10 mi. Fishing boats were carried up to 4 mi inland. In the Divi district alone over 79,000 acres were under sea water. The storm surge roared through more than 150 villages and hamlets with such enormous force

Table 3.--Recent cyclone history of Andhra Pradesh, Tamil Nadu

Year	Dates	Estimated maximum winds (kn)	Estimated minimum pres. (mb)	Coast crossed	Remarks
1956	Oct. 26-31	65		south of Guntur	Markapur had 8.9 in of rain on the 30th.
1962	Nov. 26-29	74	974	near Nellore	
1963	Oct. 19-24	80	984	near Cuddalore	Heavy rain caused serious flooding and crop damage.
1964	Nov. 3-8		990	near Madras	Madras had about 11 in of rain; 30,000 homeless in widespread flooding.
1964	Dec. 17-24	65	970	south of Tondi	Hurricane-force winds for 6 hr at Dhanushkodi on Rameswaran Is. Storm surges estimated at 15 ft; 500 deaths and heavy crop damage.
1965	Dec. 29-Jan. 3	70	994	near Vishakhapatnam	Heavy widespread rains.
1966	April 28-May 4	65		near Cuddalore	Cuddalore had 13.1 in of rain on May 1.
1966	Nov. 1-11	110	961	south of Madras	Heavy damage at Port of Madras.
1967	Dec. 4-8	70	980	near Nagappattinam	Heavy rains, gales, and storm surge responsible for 7 deaths and 15,000 people homeless.
1969	Nov. 4-9	95	970	between Masulipatam and Kakinada	Rain, wind, and flooding caused 200 deaths and heavy crop damage. Storm surge affected coast areas from Vishakhapatnam and Coringa.
1972	Sept. 7-14	110	957	near Barura	Storm surge 3 to 9 ft above high-tide level between Chandbali and Barura.
1972	Nov. 15-23	80	983	south of Nellore	No loss of life, little storm surge, but wind and rainfall damage.
1972	Dec. 1-8	75	984	near Cuddalore	Heavy rains, high winds caused considerable crop damage. Flooding widespread. Estimated 80 deaths.

that the carcasses of buffaloes and cattle were found lodged in trees 15 ft above the ground. In addition to the sea water, up to 15 in of rain fell within a few hours over a wide area.

Thus far, the official death toll stands at about 11,100 with another 4,000 people missing. Most of the suffering was in Andhra Pradesh, where up to 2 million people were reported homeless as some 65 villages were devastated; 21 of these were completely washed away. Table 3 gives a brief history of storms affecting this region. None comes close to the intensity of this one.

The first cyclone struck the central coast of Tamil Nadu State. The resulting floods destroyed over 20,000 acres of paddy and partially damaged another 190,000 acres. Ironically, the storm filled reservoirs and tanks with enough water to irrigate a new crop. However, this new paddy crop would not be harvested until next spring. Apparently, people heeded early warnings and moved to higher ground, thus limiting the number of casualties. After moving into the Arabian Sea this tropical cyclone reintensified and turned landward again. Moving northward along the west coast, she lashed the northern section of the Kerala State and the Lakshadweep Islands before hitting the Karnataka coast just south of Marmagao on the 21st. The island of Kiltan was almost submerged; coconut palms, which provide the main source of revenue, were heavily damaged. Most of the interisland boats were lost.

The second tropical cyclone, which had been expected to hit Tamil Nadu, instead struck the central coast of Andhra Pradesh on the 19th. About 1.5 million acres of paddy were damaged in Andhra Pradesh. Spice, tobacco, sugar cane, and cotton crops were also damaged. Damage was heavy in the city of Guntur, where roofs were blown off warehouses, exposing the contents to 10 hr of steady rain. Banana plantations were a total loss. There is fear that the flooding by sea water will raise the salinity of the soil and spoil it for cultivation.

"Overnight villages have been turned into burial grounds," said Khrishna Rao, Minister of Education in Andhra Pradesh. Indians burned the bodies of storm victims in huge funeral pyres. Mass burials have been hampered by the waterlogged conditions of the soil in some areas. It is feared that the final death toll may reach 20,000; one of India's worst disasters.

On the Editor's Desk

LATEST CLOSING EVER FOR ST. LAWRENCE SEAWAY

All vessels finally cleared the St. Lawrence Seaway and the Saint Lambert Lock at Montreal on December 26, 1977, almost 2 weeks after the official closing date of December 15 and the latest closing ever.

The last vessel to leave the system was the 18,350-ton Swiss freighter ST. CERGUE, which departed Duluth on December 14 with a 10,000-ton cargo of sunflower seed. It was followed by the U. S. Coast Guard icebreaker WESTWIND, which was on its way to an East Coast shipyard for repairs in the wake of damage caused by a grounding in the St. Marys River 2 weeks before. The WESTWIND's replacement in the Upper Great Lakes, the NORTHWIND, had already transited the Montreal-Lake Ontario section and was scheduled to clear the Welland Canal on the 26th.

It happens every year, but this time because of strikes which had delayed loading and an unusually early cold with persistent fog conditions, some 88 oceangoing vessels and half that number of lakers appeared to stand little chance of exiting the system before the inevitable freezeup.

The extended season further added to the Seaway's record year. As of December 21, estimates by the U. S. St. Lawrence Seaway Development Corporation show that some 62.5 million tons of cargo had passed through the system since May. The previous record was 57.6 million tons in 1973.

Credit for the achievement of getting all the ships out is given to the work of United States and Canadian icebreakers, an unexpected spell of relatively mild weather, and extra efforts by the piloting community.

The Canadian icebreaker NORMAN MCCLEOD followed the Swiss freighter out of the lock and will begin regular icebreaking operations in the lower St. Lawrence River.

The Seaway will officially reopen some time in April 1978, but this year's near miss for such a large number of ships draws attention once again to risks involved in gambling on last-minute exiting and the need to speed up work on plans being studied to extend the Seaway season.

WELLAND CANAL CLOSES

The Welland Canal was closed for the 1977 shipping season on schedule at midnight on December 30. Although the weather had turned colder and ice had formed along the waterway, the last ships were able to move through the canal without any serious difficulty.

The Montreal-Lake Ontario section of the Seaway closed on December 26, 1-1/2 weeks after the official closing date of December 15. It marked the latest closing ever for that portion of the Seaway system.

The extremely late closing of the Montreal-Lake Ontario section stemmed from the presence of an unusually large number of ocean vessels in the Great Lakes this year. In addition, the traditional late-season rush to make it out of the Seaway system before the onset of winter was slowed by bad weather, poor visibility, and pilot shortages.

Cargo volume on the Welland was a little more than 10 percent above the 1976 levels as of December 7, according to the Seaway Authority. Also, more than 70 million tons of cargo transited the Welland through December 26, far surpassing the previous high mark recorded in 1973.

Great Lakes bulkcarriers who used the Welland in the closing days of its 1977 season had problems from

a 9-day-old Federal employees' strike that, among other things, shut down the vertical lift bridge spanning the entrance to Hamilton Harbor on Lake Ontario. All nine Great Lakes vessels that had been waiting to enter Hamilton departed on December 29.

Some diversions had already occurred earlier in the week with cargoes either being unloaded at other Lakes ports or vessels moving on to other ports for winter berthing.

WEATHER SERVICE ISSUES NEW MID-RANGE OUTLOOKS

In December 1977 the National Weather Service began issuing a new type of weather outlook for the period 6 through 10 days ahead. The new outlooks will help to fill the gap between the 5-day short-range forecasts and the long-range outlooks, which extend through 30 days for temperature and precipitation and 90 days for temperature.

The Weather Service's National Meteorological Center will issue the new outlooks three times a week in both map and narrative form (fig. 42). Each issuance will contain predictions of average temperature and precipitation for the 5-day period beginning on the 6th day ahead and ending on the 10th. Predictions will be for averages expected throughout the period, not for expected conditions on each individual day. Future mid-range outlooks may also be issued for heating degree days and winds.

The new outlooks will carry predictions for temperature in the following categories: much above normal, above normal, near normal, below normal, and much below normal. Predictions for precipitation will be for above normal, near normal, below normal, or none.

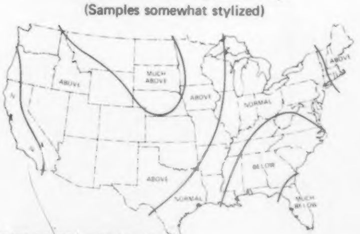
The Weather Service has been making predictions for this mid-range period on an experimental basis for more than a year. The skill shown was more than enough to convince Weather Service officials that such predictions would be useful. For example, when ice covered the Chesapeake Bay last winter--a rare occurrence--and idled fishermen, Governors of adjacent states requested Federal aid. Disaster agency officials asked the National Meteorological Center for a temperature outlook and received a prediction for 5 moderate days followed by more severe cold on the 6th through the 10th days, which proved correct.

The Weather Service plans to canvass a number of agencies to find a wide range of ways the new outlooks can be used. Already, a Weather Service study shows the following activities are good candidates, being especially weather-sensitive: fishing, agriculture, air transport, forestry, construction, land and water transportation, energy use, health and safety, resources utilization, merchandising, water-supply planning, communications, recreation, and manufacturing.

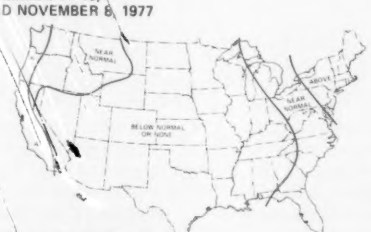
The new outlooks were made possible in part by a computer model of the Earth's atmosphere designed by Lloyd W. Vanderman of the National Meteorological Center. Vanderman's model predicts winds and temperatures up to 6 mi high, as well as precipitation amounts. Because of the model's relative simplicity, it can produce 6th through 10th day outlooks in 90 min on one of the large, fast computers at the National Meteorological Center.

SIXTH- THROUGH TENTH-DAY OUTLOOKS FROM NOAA'S NATIONAL WEATHER SERVICE

Temperature and Precipitation Maps
(Samples somewhat stylized)



5-DAY AVERAGE TEMPERATURE OUTLOOK (FOR SIXTH THROUGH TENTH DAY AFTER ISSUANCE) FOR NOVEMBER 14-18, PREPARED NOVEMBER 8, 1977



5-DAY AVERAGE PRECIPITATION OUTLOOK (FOR SIXTH THROUGH TENTH DAY AFTER ISSUANCE) FOR NOVEMBER 14-18, PREPARED NOVEMBER 8, 1977

Temperature and Precipitation Narrative Summary

The National Weather Service's 6-10 day outlook for Monday, November 14 through Friday, November 18, calls for temperatures to average above normal from the Mississippi Valley to the Pacific Coast with much above normal in the Northern Plains. Above normal is also indicated for New England. Temperatures will be below normal in the Southeast. About normal is expected in the Lakes Region, Ohio Valley, and mid-Atlantic States.

Precipitation is expected to be below normal over much of the Nation except for above normal amounts in the Pacific Coast Region and Northeast. Near normal amounts are expected in the Lakes Region, Southeast, and the Pacific Northwest.

Figure 42. --Examples of new outlooks.

MARINE SAFETY INFORMATION SYSTEM

The Department of Transportation announced in October that a new computerized Marine Safety Information System (MSIS) is now operating to provide Coast Guard Port Captains with up-to-date safety records on United States and foreign vessels entering U. S. waters. Coast Guard officials expect the new system to help cut down the number of shipping accidents.

President Carter directed the establishment of the MSIS following last winter's rash of foreign tanker accidents in U. S. waters. At that time the President ordered the Coast Guard to begin boarding and examining all foreigh-flag tank ships entering U. S. ports and to establish an information system to keep track of the safety and pollution records of all vessels.

Using the MSIS, Captains of the Port, marine safety and inspection offices in 52 cities on the Atlantic, Gulf, and Pacific coasts, the Mississippi River system, and the Great Lakes can obtain vessel histories through a telephone connection to a computer

terminal. Four categories of information are maintained in the MSIS data bank: violation histories, boarding and inspection histories, casualty records, and pollution incidents. MSIS is operational 24 hours a day, and its continuously updated information is immediately retrievable by Coast Guard boarding and examination personnel prior to a vessel making a port call.

All vessels required to give advance notice of arrival to Coast Guard Captains of the Port will be included in the MSIS. This includes tankers and general cargo vessels, but excludes fishing vessels and pleasure craft. When advance notice is received, the local Port Captain requests the vessel's history from the MSIS. This information is used to determine allocation of resources and to ascertain the nature of previous Coast Guard boardings and inspections, in addition to advising the Port Captain if the vessel was in compliance with safety and environmental protection regulations. Using MSIS, boarding and examination personnel can also check their findings against previous examinations to determine whether violations have been corrected.

Thirty-four Coast Guard units are now equipped with MSIS computer terminals, and plans call for expansion to 55.

NEW U.S. GREAT LAKES PILOT

NOAA has announced that the 1978 edition of the United States Great Lakes Pilot will be published as the United States Coast Pilot 6.

The 600-page volume, known as the "Bible of the Great Lakes mariner," is published annually by NOAA's National Ocean Survey. The name change is in keeping with the other eight Coast Pilots and in no way alters the contents of the volume which will include the information from 1977's first full inspection of the Great Lakes marine and navigational facilities, the upper Hudson River, U.S. part of the St. Lawrence Seaway, and the New York Barge Canal.

The United States Coast Pilot 6, scheduled for publication in April 1978, supplements the navigation information shown on standard nautical charts by furnishing details that cannot be shown graphically on marine charts, such as channel and anchorage peculiarities, navigation regulations, weather, port facilities, and prominent landmarks. Other data in the new volume will include signals for opening locks and bridges, clearances of bridges and other structures, outstanding landmarks, descriptions of shorelines and harbors, U.S. laws and regulations, and dimensions and capacity of dry docks and marine railways.

The first Great Lakes Pilot was published by the U.S. Lake Survey (U.S. Army Corps of Engineers) in 1889.

OCEAN COLOR EXPERIMENT UNDERWAY IN GULF

Two oceanographic research vessels and four aircraft scanned the Gulf of Mexico during October 1977 to confirm that determining water color with satellite-borne instruments is a realistic way to measure sediment, temperature, and other properties of the ocean.

The test by NOAA's Satellite Experiment Laboratory is preliminary to the launch of the NIMBUS-G satellite in 1978. Among the instruments that the spacecraft will carry will be a coastal zone color scanner which, it is expected, will give scientists a far-superior method of determining ocean properties.

The Gulf project, a joint NOAA-NASA study, is using the NOAA ship RESEARCHER, the Texas A&M University research vessel GYRE, and four NASA aircraft, including a U-2 high-altitude jet. Both the U-2 and a NASA Lear jet are equipped with laboratory models of the coastal zone color scanner. As they overfly a section of the Gulf recording measurements, the two research ships beneath take actual water samples for analysis, to confirm the aircraft instrument readings.

Results of the Gulf program will test formulas for use in deriving ocean information from the scanner once it is in orbit aboard NIMBUS-G.

Among the properties the coastal zone color scanner is expected to measure are chlorophyll, sediment, water temperature, and the effect of sunlight upon the ocean. An important side benefit of the instrument will be its ability to "see" and track oil slicks in ocean waters.

RADAR MEASURES SEA SURFACE CURRENTS

A current-sensing radar developed by NOAA may become a major tool for monitoring sea pollutants and setting environmental baselines where petroleum and other exploration are planned. The radar permits monitoring of surface currents up to 50 mi and enables production of current-movement computer maps over 750 sq mi every 1/2 hr.

The new radar system was developed by scientists with NOAA's Wave Propagation Laboratory in Boulder, Colo. It could provide an effective alternative to surface drifters, drogues, and other ocean current determination methods now used that measure water motion only at a single point.

Tests of the experimental system were conducted from southern Florida's east coast with the aid of Nova University. Subsequent tests last summer in Alaska's Cook Inlet, noted for its large tidal currents and the proposed site of offshore petroleum development, largely confirmed the Florida results.

The Alaska results showed that a single current-vector map covering thousands of square kilometers can be produced after only 15 min of operation. Many times more data can be gathered in a 12-hr period than by any alternative technique, and the system error is at worst 1/2 kn of current velocity.

The experimental system is a pair of transportable, high-frequency pulsed radars, each controlled by a minicomputer. Echoes from the sea surface at points about 2 mi (3 km) apart on an imaginary grid are received by two sets of antennae.

The antenna frames are placed on the beach near the waterline, where wet sand grounds them, and helps push their signals out beyond the horizon over the ocean's electrically conductive surface. Conventional over-the-horizon radar requires a signal-relaying bounce off the ionosphere to move the pulses out beyond a line of sight. The new radar system deduces ocean current velocity by sensing

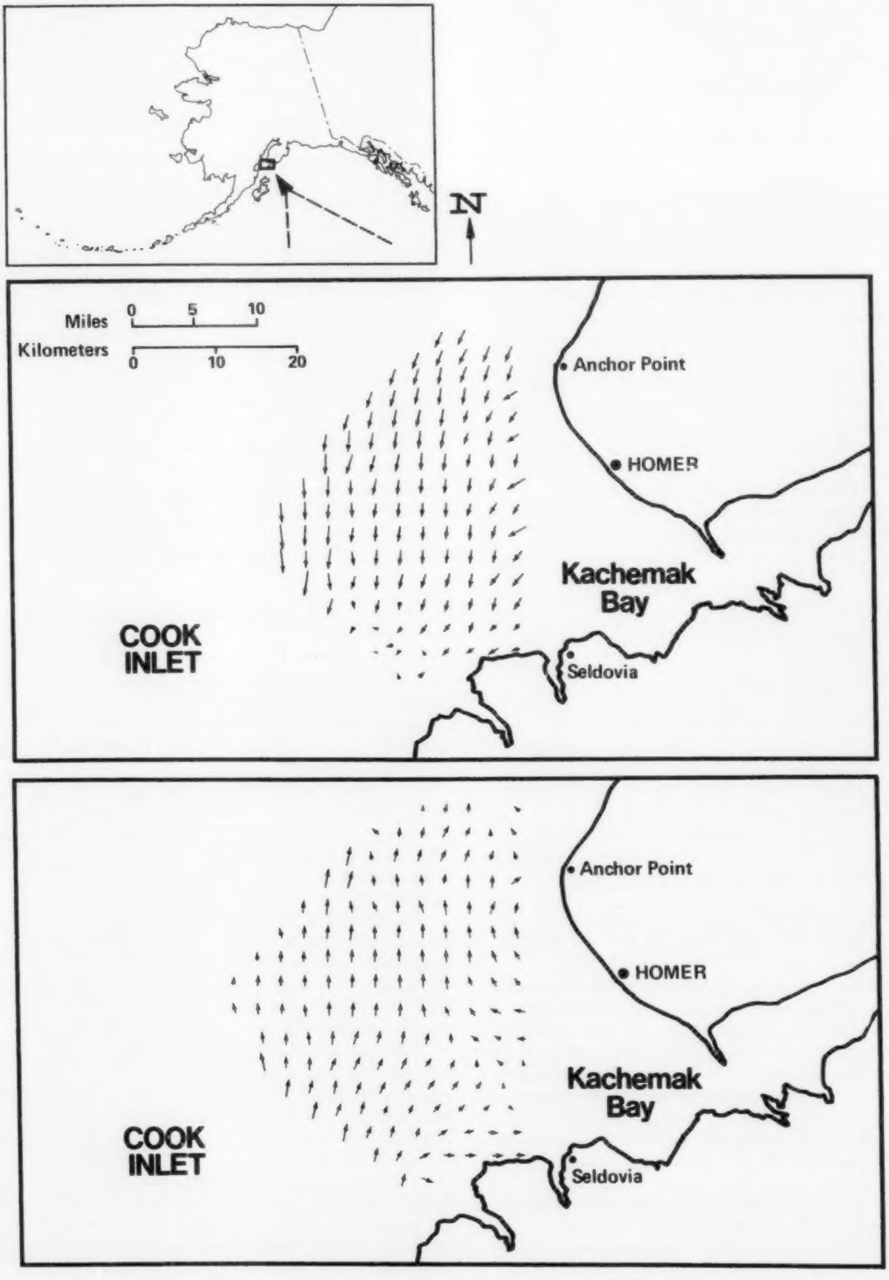


Figure 43.--Sea-surface currents as detected by the NOAA radio in Cook Inlet at two different times on July 1, 1977.

the scattering of radar echoes by ocean waves. The radar-controlling minicomputer processes the signals and current data while the system is operating and draws a map of the surface current velocity at each grid point, clearly showing the speed and direction of surface currents over the area scanned (fig. 43).

WORLD'S FIRST SOLAR-POWERED HARBOR

The U. S. Coast Guard is adapting space age technology to convert solar energy into electrical power for 50 navigation buoys and shore aids in the waters off Miami, Fla.

Solar energy panels, initially developed for use in space, are mounted on each navigation aid and store sufficient energy during daylight hours to power a flashing light to guide mariners at night.

The Coast Guard currently maintains 14,000 lighted buoys and minor shore lights in coastal waters from Maine to Alaska that depend on costly, bulky zinc-air cell batteries for power. Solar power has several advantages over non-rechargeable batteries in terms of weight, longevity, and pollution potential.

Although a solar power unit costs more than one rack of batteries, it will last at least 6 yr, while batteries last only 2 yr. Using today's costs, the investments are equivalent after 3 yr, so the remaining years of the solar power unit are free. In fiscal year 1980 the annual saving in energy costs using solar power could exceed $3 million.

The conversion of 50 aids in Miami is the first step in a three-phase development program for evaluating solar power on Coast Guard aids to navigation. The second step will be to tackle the next biggest aids, such as the reef lights off the Florida coast, using a combination of wind and solar power, and finally, development of a hybrid system for use on major light stations.

BUOYS MONITOR HURRICANES

Early in the morning of August 28, 1977, a poorly defined tropical atmospheric disturbance, or easterly wave, moved off the Florida coast, entered the Gulf of Mexico, and continued its westerly movement toward three National Data Buoy Office (NDBO) data buoys--EB-44, EB-04, and EB-71--moored across the central Gulf (fig. 44). Later that same day, while moving westward over the two closest buoys (EB-44 and EB-04), the low-pressure trough of the wave became better defined, with strengthening southeasterly

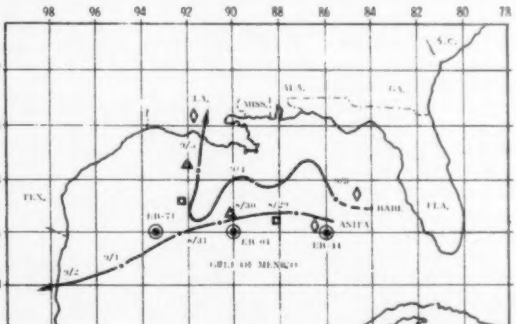


Figure 44.--The tracks of hurricanes Anita and Babe in relation to the buoy positions.

winds being reported from EB-44 (26°N, 87°W) and northeasterly winds being reported from EB-04 (26°N, 90°W). As a result of this change, and to provide closer monitoring of potential development of this tropical wave, the forecaster at the National Hurricane Center (NHC), Miami, requested hourly observations from all three buoys starting at 0000 August 29, as opposed to the normal 3-hr observation cycle. Since intensification of this wave into a tropical depression would be accompanied by the development of a closed wind circulation around the low-pressure area, and because the low pressure of the trough was to the north of the buoys, forecasters were carefully watching the buoy wind directions, especially from EB-04. The first indication of the anticipated closed circulation came from the 1200 August 29 report from EB-04, which showed a brisk westerly wind. With the knowledge that a tropical depression was forming, NHC forecasters were confident in requesting expensive aircraft reconnaissance to investigate the area.

With continued hourly buoy data, especially from EB-04, in conjunction with aircraft data, the slowly intensifying tropical depression was tracked as it drifted westward. At 1000 on August 30, in a position just northwest of EB-04, tropical storm Anita was christened. Less than 12 hr later, the storm became a full-fledged hurricane about 60 mi west-northwest of EB-04. The pressure, wind, and ocean wave reports from this buoy were of considerable value to NHC forecasters. Early on September 1, as hurricane Anita moved slowly west-southwestward, her center (or eye) passed just to the south of EB-71, which reported maximum sustained windspeeds of 38 m/sec (74 kn) and associated significant wave heights of 7 m (23 ft). These values were considerably greater than those reported by EB-04, as would be expected. Lower pressures, to 982 mb, were also reported from EB-71. The data reports indicated slow, but continued intensification of the hurricane. Shortly thereafter, Anita entered the shallow waters off the Mexican coast and began to intensify rapidly. During the early morning hours of September 2, Anita delivered her full force of over 75 m/sec (145 kn) winds to the northeast coast of Mexico.

As Anita was dissipating over Mexico, another easterly wave entered the Gulf of Mexico from Florida and moved to a position just northeast of EB-44. All three buoys were still reporting hourly observations and continued to do so to monitor this new system. At 0000 on September 3, observations from EB-44 indicated westerly winds. According to the NHC forecasters, this was the first indication that the closed circulation of a tropical depression had developed just north of EB-44 and warranted careful monitoring. The tropical depression moved slowly northwestward and by midday had intensified to tropical storm Babe. Babe followed the track indicated in figure 44 and came fairly close to EB-04 and EB-71. When Babe later intensified to hurricane strength over the shallow waters of the northern Gulf of Mexico late on the 4th, she was at least 200 mi from the nearest buoy. Buoy data did help define the early development and track.

This was the third time in as many years that data buoys delivered hourly data for sustained periods to monitor hurricanes directly. This was also the long-

est period in which hourly reports were generated during such conditions, and was the first time that small, 6-m, boat-shaped NOMAD buoys (EB-44 and EB-04) were involved. However, the NOMAD buoys were exposed only to tropical storm conditions. The buoys delivered valuable data to NHC from August 29 to September 6, 1977, and their performance on the 1-hr data delivery cycle was nearly perfect (over 98 percent) for meteorological data and just slightly less (97 percent) for oceanographic data.

GLOBAL MARINE CASUALTIES SET RECORD HIGH

World fleet casualty losses during 1976 were the highest ever recorded, according to Lloyds Register of Shipping Statistical Summary of Casualties. Tonnage lost totaled 1,156,109 tons, an increase of 160,848 tons over 1975, with 345 ships lost, 9 more than 1975.

Wreckage figures were also up substantially, accounting for almost 52 percent of tonnage lost at 132 ships of 600,997 tons against 107 ships of 315,428 tons for the previous year. The largest ship ever lost, the 126,622-ton OLYMPIC BRAVERY, was included in this category.

Tonnage lost by foundering and collision decreased. Of 111 ships foundering, nearly one-third were over 20 yr old; and of the 32 vessels of 53,225 tons lost through collisions, at least 6 took place in bad visibility or fog.

Thirty-two tankers of 558,426 tons (48 percent) were lost, 8 bulkers of 122,567 tons (11 percent), 185 freighters, plus 82 fishing craft. Forty ships were known to be in ballast.

Forty-nine percent of ships casualties were under 500 tons with 32 of over 10,000 tons lost. Eight percent of all ships were less than 5 yr old, with 24 percent over 25 yr. Panama lost 1.39 percent of her fleet, followed by Spain at 1.18 percent, Greece at 0.51 percent, Liberia at 0.48 percent, Singapore at 0.35 percent, India at 0.22 percent, and Japan at 0.14 percent. These numbers were all up on 1975 except for Greek- and Singapore-flag tonnage which registered a drop of 0.14 and 0.53 percent, respectively. Japan lost the most ships at 52, but Liberia suffered the most tonnage lost at 353,771 tons.

PUBLICATIONS OF INTEREST TO MARINERS

NEW NAVY ATLAS FOR THE PACIFIC

The U. S. Navy Marine Climatic Atlas of the World, Volume II - North Pacific Ocean (Revised 1977) NAVAIR 50-1C-529, is now available through the Superintendent of Documents, U. S. Government Printing Office, Wash., DC 20402. The GPO Stock Number is 008-042-00068-3; the cost is $27.50.

The eight-volume series, U. S. Marine Climatic Atlas of the World, has had wide acceptance as an authoritative reference for large-scale operational planning and applied research. This updated version of the long out-of-print 1961 Volume II includes nearly 20 yr of additional data. It is not a one-for-one revision of the 1961 atlas however. Some of the data presentations have been changed, and wave statistics have been added. No upper air charts are presented since in recent years several comprehensive volumes of upper air data have been published separately.

The data for the atlases in this series are obtained from ships' weather observations. In the past 3 decades the Ocean Weather Station (OWS) networks, maintained through the cooperation of several maritime nations, have provided a good approximation to the "point statistics" of land climatology. Beyond the coverage of the 5 North Pacific Ocean Weather Stations, there remain vast areas for which transient ships' logs of surface weather observations are the only source of detailed knowledge of ocean climate. The National Climatic Center has taken ship observations collected by the major maritime nations and placed them into one tape deck, Tape Data Family-11 (TDF-11), in a common format. This tape deck was used in the computations for this volume.

The atlas is a monthly, seasonally for some oceanographic data, presentation of isopleth analyses supplemented by graphs and tables. The analyses were completed by a team of analysts under the leadership of R.G. Quayle and D.C. Fulbright. The basic maps were automatically plotted from 1- or 2-degree square summaries for the entire ocean area. To supplement the isopleth analyses, graphs and tables are presented for each of the Ocean Weather Stations and selected representative areas.

The atlas contains analyses of winds, air and sea temperatures, precipitation, cloudiness, visibility, humidity, pressure, extratropical and tropical cyclones, and waves. Some of these parameters are also analyzed in various combinations. The oceanographic section presents information on tides, currents, and ice.

This volume is the third of the series. Volumes covering the Atlantic Ocean (Volume I) and the Indian Ocean (Volume III) have already been published.

LATE BULLETIN

Walter J. Stoddard, the Port Meteorological Officer for New York for 9 yr, retired on January 27, 1978, after 35 yr of Government service, 17 of which were associated directly with marine weather. Walt will be missed by his many friends in the marine community.

MARINE WEATHER REVIEW

The SMOOTH LOG (complete with cyclone tracks [figs. 49-52], climatological data from U.S. Ocean Station and Buoys [tables 4 and 5], and gale and wave tables 6 and 7), is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The ROUGH LOG is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both the SMOOTH and ROUGH LOGS, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

Smooth Log, North Atlantic Weather

July and August 1977

SMOOTH LOG, JULY 1977--The majority of cyclones this month were concentrated over northern Canada and the Labrador Sea. Over the water area the primary path was from Labrador eastward and northeastward toward Iceland. The northeasterly storm track off the U.S. East Coast was only lightly traveled. One storm from Spain and the Mediterranean traveled across central Europe. Two cyclone centers passed north of Scotland into Scandinavia, where they turned sharply northward.

The monthly mean pressures did not differ greatly from climatology. The largest and primary feature over the water was the Bermuda-Azores High at 1029 mb. Its center was near 38°N, 31°W, or about 400 mi northwest of its normal 1025-mb position. There were three low centers over or near the northern waters verses the normal two. A 1011-mb center was near 62°N, 28°W. A 1005-mb center at 56°N, 58°W, and a 1006-mb center at 61°N, 75°W, replaced the normal 1008-mb center near Cape Chidley. The pattern followed the basic configuration with ridges stretching toward the southeastern United States and northern Europe.

There were two areas of significant anomalous pressures. One large, positive area occupied the northeastern quarter of the ocean from latitude 30°N northward. A narrow neck of this area stretched across the Norwegian and Barents Seas to another center over Siberia. A negative area was centered over the Labrador Sea off Hamilton Inlet.

The upper air pattern at 700 mb differed in several significant aspects from climatology. The High over midocean was several meters higher than normal, and the center shifted eastward from near 30°N, 50°W, to 36°N, 38°W. The low-pressure trough that normally parallels Canada's northeast coast was wider than usual with a closed LOW near 62°N, 77°W, over Cape Wolstenholme. The low-pressure trough over and along the western European and northwest African coasts was much sharper than usual.

There were the usual number of disturbances in the Tropics, but none developed into tropical storms or hurricanes. This is not highly abnormal as nearly one-third of the seasons this century did not produce tropical cyclones in June or July. The longer the season progresses without a tropical cyclone, the more abnormal it becomes.

Extratropical Cyclones--The dominant feature over the water this month was high pressure. The cyclones were forced well to the north, and except for three isolated occurrences off the U.S. East Coast, there were no storm centers south of 49°N. Most of the storm centers tracked north of latitude 55°N, except in the Labrador Sea.

This storm formed on the 5th over the St. Lawrence River at latitude 48°N, but it was above 50°N by the time the center was over open water. At 1200 on the 6th, the storm was 995 mb over Newfoundland. The SAGUENAY was in the Gulf of St. Lawrence with 55-kn winds from the north. At 0000 on the 7th, a Swedish ship reported 48-kn winds off the Gaspe Peninsula. The PIONEER COMMANDER was near the front at 49.8°N, 42.7°W, with 42-kn southerly winds and 18-ft seas. At 1800 the oil/ore carrier H1070 had 50-kn easterly winds about 150 mi southwest of Kap Farvel. The BERGLJOT measured 36-kn winds and 15-ft swells about 800 mi south of the cape.

On the 8th the LOW was weakening rapidly, but there were still strong winds along the front. The CETRA COLUMBA and DGCE were near the front in the vicinity of 43°N, 44°W, with 63- and 60-kn winds, respectively. By the 9th the LOW had completely filled.

As the point of occlusion of a frontal system moved over Goose Bay, Labrador, on the 14th, a closed LOW was analyzed. At 0000 on the 15th, the IVAN MOSKVIN, south of St. Mary's Bay, radioed 48-kn winds and 12-ft seas. On the 16th the CHEMBARGE was north of Belle Isle with 44-kn winds. The LOW was racing eastward at about 30 kn, and at 1200 it was 1000 mb near 58°N, 25°W. As the storm approached Rockall Bank, it slowed and deepened slightly to 993 mb at 1200 on the 17th. Ocean Weather Station Lima reported 35-kn winds as the center moved north of her position. Two ships near 56°N, 14°W, also had 35-kn gales with one reporting 16-ft seas. The DOCTOR LYKES was in the English Channel on the 18th with winds of 40 kn and seas of 8 ft. On the 19th the

LOW stalled over Norway and the AMERICAN LEGEND had 40-kn winds in the North Sea. On the 20th the storm moved over the Norwegian Sea and broke into multiple centers.

This LOW formed in an area of weak pressure gradient over south central Canada on the 16th. On the 18th it moved over the Labrador Sea. On the 19th at 0000 the ZIM NEW YORK was sailing toward her namesake with 40-kn winds near 42°N, 48°W. On the 20th and 21st, the storm had multiple centers, but by the 22d it had again consolidated into one center. On the 21st the GRONLAND was near Kap Farvel with 37-kn easterly winds. On the 22d the MINDEN was south of Iceland with 44-kn winds. The LOW had been on a northerly track but turned southeastward late on the 23d. At 1200 the NQDO was on the Irish Sea with 56-kn winds. Two ships had 40-kn gales south of the center.

The storm broke into multiple centers again on the 24th, with the primary center jumping to just west of Scotland. Lima reported 35-kn winds and 13-ft seas. A ship in the English Channel reported 48-kn winds on the 25th. The center made a clockwise loop over Scandinavia on the 25th and 26th before heading due north into the Greenland Sea.

This storm formed some distance off the Virginia coast as a front pushed southeastward on the 22d. At 1800 the ATLANTICA MILANO was on the east side with 52-kn southerly winds. The seas were coded as 39 ft accompanied by 23-ft swells. By 0000 on the 23d, the LOW was 999 mb near 40°N, 63°W. The SUGAR TRADER (39°N, 65°W), north of the front, and the YUKON (36°N, 63°W), south of the front, both had 40-kn winds with 120° difference in direction. The ATLANTICA MILANO now reported 30-kn winds with 10-ft seas and 25-ft swells. The LIGHTNING near 40.4°N, 58.9°W, at 0600 was fighting winds of 60-kn and swells of 30 ft. At 1200 four U.S. ships reported 40- to 50-kn winds around the storm. They were the ALMERIA LYKES, C.V. LIGHTNING, SEA-LAND PRODUCER, and WASHINGTON TRADER. Late that day the 990-mb storm raced over St. John's toward Greenland and continued up its west coast.

Casualties--The 1,567-ton Panamanian-registered SUPREME BEAVER was at Curacao on the 6th with heavy weather and contact damages.

SMOOTH LOG, AUGUST 1977--The primary path of the storm centers was north of the major shipping lanes as climatology indicates. The major track extended from Lake Winnipeg across southern Canada to north of Hamilton Inlet on the Labrador coast. From there it paralleled the 57th parallel to dissipate south of Iceland. A few storms continued across Scotland and into the Norwegian Sea. One LOW approached the English Channel early in the month, and later two centers moved over the Channel. The east coast of the United States was very quiet with only one system along the southeast section.

Over the ocean area the mean sea-level-pressure pattern was near normal. Except for a small area east of Kap Farvel, the pressures were above the climatic mean. The significant difference in the pattern was a 1007-mb LOW over Hudson Bay. This produced a minus 4-mb anomaly in that area and reflected the passage of above-normal LOWs through the area. A 1009-mb LOW near 60°N, 30°W, marked the Icelandic LOW. The Bermuda-Azores High was 1026 mb and 3 mb higher than the climatic mean. This higher central pressure was reflected over most of the ocean and along the U.S. East Coast.

The upper air pattern differed from climatology mainly over the eastern United States and Canada. As with the surface there was an anomalous LOW over Hudson Bay, which drew the trough normally over the coast westward to the longitude of the Great Lakes. The height of the 700-mb surface was generally higher than normal over the water area.

The average number of tropical waves--10--were traced across the tropical Atlantic from Africa during the month. The first tropical depression appeared on the 29th, and it quickly developed into hurricane Anita on the 30th. This was the latest actual beginning of the hurricane season since 1967, when the first storm was named on the 30th. The first tropical storm has developed later than August 31 only five times in this century.

Extratropical Cyclones--The Bermuda-Azores High was the predominant circulation feature this month. The central pressure was generally greater than 1025 mb and wandered from near Bermuda to north of the Azores Islands. The majority of the low-pressure centers were weak and did not develop large circulations.

The first LOW of any consequence moved over Newfoundland on the 1st. It traveled slowly in a northeasterly direction until the 3d, when under zonal flow it raced toward Scotland. As it approached longitude 15°W, a ship near 56°N, 12°W, reported 35-kn easterly winds.

On the 5th as the storm moved northward off Bergen, Norway, two ships again reported 35-kn winds with the GUIY fighting 16-ft seas. At 1800 her winds were 44 kn and seas 23 ft. Many ships, probably fishing vessels, reported gales. The LOW was now 997 mb--the lowest pressure thus far. By midday on the 7th, it was 984 mb at 70°N midway between the Greenland and Norwegian coasts. Jan Mayen Island had 40-kn winds with fog, while two coastal stations off northern Norway had 40-kn winds with rain. Ocean Station Vessel Mike measured 36-kn winds. At 1800 the winds were 40 kn and the seas 20 ft. On the 8th the seas increased to 23 ft. By late on the 10th, the storm had disappeared.

This LOW developed north of the Great Lakes on the 8th. As it moved over the Gulf of St. Lawrence on the 9th, it intensified. On the 10th the USNS PVT J.R. TOWLE in the Labrador sea was hit by 50-kn winds. Two ships over the Grand Banks had gales up to 40 kn. As the storm moved along and north of the shipping lanes, it developed one of the larger cyclonic circulations for this month. The central pressure was only 992 mb, and the winds were light. The METEOR at 44°N, 33°W, had 35-kn gales and 15-ft swells.

On the 13th the storm turned northward and then westward on the 14th. On the 15th the SHACKLETON was south of Iceland with 40-kn winds and 20-ft seas. By the 16th the LOW dissipated on the coast of Greenland.

On the 18th a front out of a LOW over the Gulf of St. Lawrence moved off the U. S. East Coast. The Bermuda-Azores High at 1030 mb was centered near the Azores Islands. As the front moved eastward, the gradient east of the front increased; the DART AMERICA and two U. S. S. R. ships reported gales of 35 to 40 kn along a line from near 32°N, 68°W, to 40°N, 62°W. A few hours later the gradient relaxed with light winds.

Monster of the Month--The Bermuda-Azores High had stubbornly remained fixed near 35°N, 35°W, at about 1031 mb for several days. The same front mentioned above had just as stubbornly persisted on the northwestern quadrant. Stable frontal waves generated and dissipated along the front. At 1200 on the 21st, the ULTRASEA reported 18-ft swells in the southwesterly flow east of the front. Six hours later another frontal wave was detected near the Flemish Cap. This one was unstable and continued to develop.

The center passed slightly south of OWS Charlie late on the 22d. Charlie measured nearly 40-kn winds which shifted from east to north as the storm moved eastward. At 1200 on the 23d, the BISCHOFSTOR (47.4°N, 30.3°W) reported westerly winds of 76 kn. Not far away at 48.5°N, 30.1°W, the PAVLOGRAD had westerly 46-kn winds, and on the east side of the LOW the DART ATLANTIC (49.9°N, 11.5°W) reported southeasterly 40-kn gales. The highest seas were 13 ft.

By 1200 on the 24th, the LOW was 986 mb near 54°N, 14°W--now a fairly large storm stretching from Iceland to Portugal. OWS Romeo measured 40-kn gales and 26-ft seas. Other ships were reporting gales with seas around 15 ft. About twelve hours later Romeo was riding 30-ft seas. At 1200 on the 25th, the VALERIAN KUYBYSHEV also found 30-ft swells southeast of Romeo. The NEPTUNUS in the southwest quadrant (49°N, 21°W) was sailing with 40-kn winds and 20-ft waves. The 992-mb LOW was over the North Sea on the 26th, while OWS Romeo was again fighting 40-kn gales with 34-ft seas. Early in the morning a new LOW formed south of Ireland and kept the pressure gradient tight near the western shores. On the 27th both LOWs disintegrated.

As a front moved off the United States-Canadian coast on the 25th, a wave formed over Nova Scotia. It traveled northeastward becoming a 990-mb storm over the Labrador Sea. At 0000 on the 27th Kap Farvel reported 35-kn gales. Can you imagine -22°C temperature in the Northern Hemisphere at this time of year? That was what the thermometer read at a station on the Greenland Ice Cap near 65°N, 44°W.

At 1200 on the 27th, a ship near 57°N, 20°W, was sailing into 40-kn gales with 13-ft seas. A station on the southern coast of Iceland measured 35-kn gales. A U. S. S. R.-registered ship found 40-kn gales from the south while east of the cold front near 61°N, 15°W. To the south, OWS Lima measured 13-ft swells. On the 28th the 982-mb LOW was over Iceland. A ship off the southern coast had 16-ft swells. Several ships in the North Sea were now reporting 40-kn gales as were Icelandic fishing vessels north of the island. On the 29th two ships reported swell waves of over 20 ft south of Iceland. On the 30th the LOW moved into the Barents Sea.

This was one of the few storms in which the center originated over or even tracked across the United States. It started over Colorado on the eastern slopes of the Rocky Mountains on the 27th. It was over Labrador 48 hr later. At 1200 on the 31st the 984-mb LOW was near 57°N, 30°W. Five ships reported gales of 35 to 45 kn south of the center, including OWS Charlie who reported 18-ft seas.

By 0000 on September 1 the seas had increased to 25 ft at Charlie, and the VOLJANINE nearby at 53.5°N, 35.3°W, had 50-kn winds and 23-ft seas. By 1200 the LOW was 972 mb near 58°N, 21°W. It was now in the British zone of influence. The C.P. TRADER at 52.5°N, 23°W, reported towering 33-ft swells. Close by the RUBENS had 45-kn westerlies. Very near the center the UNIWERS WROCLAWSKI with a pressure of 978 mb had howling 60-kn southeasterly winds. No waves were reported. On the 2d the winds continued to blow at 35 to 40 kn with the seas approaching 20 ft at times. On the 3d the LOW was over the Greenland Sea.

Tropical Cyclones--The origin of Anita was a tropical wave in the Atlantic trades that moved off the African coast on August 16. This was the 30th wave of the 1977 hurricane season. Similar to many of the other perturbations seen at this time of the year, it traveled westward across the tropical North Atlantic at 15 kn. Cloudiness and showers associated with this system spread across the Bahamas on the 25th and 26th and over Florida and western Cuba on the 27th. Disturbed weather persisted for several days over southern Florida and the northern Bahamas and produced several inches of rain. This weather appears to have been part of the overall weather system from which Anita developed. On the 28th the system shifted into the eastern Gulf of Mexico, where the upper tropospheric circulation was mainly anticyclonic and conducive to development of a warm-core tropical system.

The next day a concentrated area of convection was over the east-central Gulf of Mexico, and a tropical depression formed within this cloud mass by 1200. Its center was 210 mi south-southwest of New Orleans at this time. The storm moved west-southwestward for the next 4 days, intensifying steadily. Anita attained tropical-storm strength just before 0600 on the 30th and reached hurricane force 12 hr later. Strengthening continued until a minimum pressure of 926 mb was measured just prior to landfall. This was the fourth lowest pressure on record in the Gulf of Mexico. Max-

imum winds at this time were 150 kn. On the 29th and 30th Anita's central pressure dropped at a rate of 0.5 mb/hr and increased to a rate of 2.0 mb/hr on the 31st and September 1.

Landfall occurred at 1100 September 2 along a sparsely populated region of Mexico about 80 mi north of Tampico (145 mi south of Brownsville). The nearest population center in Anita's path was the inland village of Soto La Marina, 165 mi south of the border and 24 mi from the coast.

Sea surface temperatures over the Gulf of Mexico were near normal, about 29°C, well above the threshold value considered necessary for tropical storm genesis. On August 25, several days prior to Anita's formation, the NOAA ship RESEARCHER found an eddy in the sea surface temperature field in the vicinity of Anita's path. This eddy was as much as 1°C warmer than the surrounding waters. This is considered to be part of a unique data set that may provide insight into the intensification mechanism.

The only report of casualties in connection with Anita is a UPI story stating that: "Mexico City newspapers reported floods and landslides killed 10 persons in the area from La Pesca inland to Ciudad Victoria." Property damage in the United States was minimal and mainly limited to minor flooding of low-lying areas. The portion of the Mexican coast that was most affected by the hurricane is sparsely settled and no dollar damage estimates are available. All that can be said at this time is that extensive property losses were sustained by inhabitants of fishing villages along the coast and agricultural losses by small farming communities in Anita's path. Rainfall in the United States was generally slight, with 2 in reported in southern Texas, which was considered beneficial to agriculture. Mexican rainfall reports are conflicting, but one report of a 6-hr total of 17.52 in was received from Soto La Marina.

The threatening nature of this very intense storm resulted in considerable evacuation of coastal areas. The oil industry alone evacuated more than 7,000 workers from offshore drilling platforms in the Gulf of Mexico. Nearly 10,000 people were ordered inland from southeast Louisiana coastal communities threatened by high tides. Along the upper coast of Texas as many as 35,000 people were temporarily relocated to higher ground. Estimates range up to 10,000 residents and vacationers fleeing inland from southern Texas coastal islands. Finally, the New York Times reported that the Mexican Army evacuated 35,000 people from villages along a 240-mi stretch of coast from Tampico north to the United States border.

Maximum tides along the Texas and Louisiana coasts were 3 to 5 ft above normal. Maximum sustained winds of 55 kn in the United States were reported from the Coast Guard Station on South Padre Island, Tex. An insurance company with instrumentation on the Bahia Mar condominium reported a 5-min average wind of 81 kn.

Casualties--On the 5th the U. S. Navy tanker POTOMAC had a 10- by 12-ft hole punched in her fuel tank by ice in Melville Bay and spilled approximately 3,000 barrels of oil. A search was made in the vicinity of St. Pierre and Miquelon for the Canadian trawler CAPE ROYAL, which was hampered by fog and overdue. The American PIONEER COMMANDER (11,115 tons) grounded in fog on the 13th at 58.7°N, 02.1°W. The Nos. 2 and 3 holds were damaged by slight oil leakage. The 13,600-ton Hungarian freighter ADY and the 7,554-ton Singapore-flag NORDWOGE collided in the Scheldt River in dense fog on the 21st. The ships stuck together and were towed to Schaar Van de Noord, where torches were used to separate them.

Smooth Log, North Pacific Weather

July and August 1977

SMOOTH LOG, JULY 1977--The only distinct concentration of storm paths this month was in the higher latitudes north of 50°N. There were only a few storm tracks south of that latitude. One started south of 30°N and tracked into Alaska. There was one primary track out of the Asian continent into the Sea of Okhotsk, but most of the storms were then diverted northward by anomalous high pressure north of Alaska. Only one significant cyclone formed off Japan, and it wandered into the Bering Sea. There was a favorite path across the Gulf of Alaska between latitudes 50° and 55°N. This was the only track that matched its climatological counterpart.

The mean pressure pattern was one large area of high pressure. The only closed LOW near the ocean was the usual heat LOW near the desert southwest and northwest of Mexico. The Pacific High was normally centered near 40°N, 150°W, at 1028 mb, or 3 mb higher than climatology indicates. There was an anomalous 1023-mb HIGH centered north of Point Barrow. The only indication of low pressure over the northern ocean was a trough in the Gulf of Alaska.

The most important anomaly was a plus 12-mb center associated with the high-pressure center north of Alaska. There was a negative 3-mb center over the Gulf of Alaska associated with the trough. Except for that negative center, the remainder of the ocean north of about 25°N basically reflected positive values.

The surface High north of Alaska was reflected in the 700-mb height over that same area. There was a closed Low over the Bering Sea that was not reflected at the surface. This Low, combined with higher values for the High over the central ocean, produced a tighter gradient across the 40° to 50°N latitude band. In general, heights were lower than normal for a 10° to 20° latitude band that stretched eastward from the central Bering Sea across Canada.

Three typhoons--Sarah, Thelma, and Vera--and tropical storm Wanda roamed the western ocean during the last 2 weeks of the month. Hurricane Claudia patrolled the eastern ocean.

Extratropical Cyclones--The cyclones, except for the tropical variety, were weak this month. The winds reported and the strongest waves would be considered insignificant for a winter month.

This was the long-lived storm mentioned earlier that started south of 30°N over the western ocean on the 3d and ended over Alaska on the 12th. It seemed to pop out of nowhere on the 0000 analysis of the 3d, near 29°N, 152°E. The pressure and height gradients were very flat over that area of western ocean from the surface through 700 mb. Observations were scarce. The LOW drifted northeastward and then northwestward, turning northeastward again on the 6th. At 0000 on the 8th, the 1002-mb LOW was near 41°N, 162°E. The reliable reporter ASIA BOTAN was northwest of the center with 62-kn winds. A ship about 400 mi southwest of the center had 16-ft seas. On the 11th the LOW reached its lowest pressure of 996 mb and slowly filled from that point as it moved across the Alaska Peninsula to disappear over the Seward Peninsula on the 12th.

The Pacific High, centered near 40°N, 140°W, during the first part of the month, started moving westward on about the 16th. On the 20th the HIGH was 1035 mb near 42°N, 165°W. A front was pressing from the northwest edge, and a small HIGH formed northwest of the front. This brought a cyclonic circulation, and late on the 20th a cyclone developed near 50°N, 177°W. At 1800 on the 21st, the MIHO MARU (52°N, 168°W) had 44-kn winds and 16-ft swells. Six hours later she had 40-kn winds 250 mi southwest of the 992-mb center, which was at 55°N, 164°W. On the 23d the AMERICAN LARK was just south of the cold front (44°N, 152°W) with 16-ft swells. Later that day the HILLYER BROWN was sailing toward Alaska with 35-kn winds. About this time the Pacific High started breaking down, and the LOW turned southeastward and filled to 1025 mb by the 25th. A distinct circulation was apparent until the 28th.

Cyclogenesis with the formation of a LOW and frontal system occurred over the Sea of Okhotsk late on the 20th. By 0000 on the 23d, the 996-mb LOW was near 53°N, 173°E. The GLADIOLUS was near 42°N, 167°E, with 42-kn winds and 13-ft waves. Six hours later the winds had dropped to 36 kn, but the waves increased to 15 ft as she moved with the storm. On the 24th the storm was over the Bering Sea and turned westward. The circulation still extended south to 45°N. The FRIENDSHIP was near 50°N, 169°E, with 35-kn gales on the 25th, but late that day the LOW was absorbed by another which had approached from the west.

As the above LOW retreated westward, another LOW developed in its wake over the Bering Sea. It increased its area of influence and moved eastward rapidly. It was 984 mb near 57°N, 167°W, on the 26th. The PACBARON was in the southwest quadrant with 45-kn winds. At 1800 the GLADIOLUS had sailed to 45°N, 163°W, and now had 42-kn winds with 13-ft seas. A report without a call sign from 49°N, 164°W, on the 27th indicated westerly 54-kn winds and no seas. The GLADIOLUS was moving along 44°N with the storm and faithfully reporting. Her winds were in the 40-kn category. On the 29th the storm stalled over the Gulf of Alaska.

Tropical Cyclones, Eastern Pacific--Claudia became the season's first hurricane on the 4th. She was first detected on the 3d about midway between Clipperton and the Socorro Islands and she intensified quickly. Cruising west-northwestward her maximum winds climbed to 80 kn for a brief time, but on the 5th Claudia fell to tropical storm strength. She continued on the same course at about the same intensity until the 6th. By the 7th she began dissipating and finally dropped off the weather charts near 16°N, 130°W.

Tropical Cyclones, Western Pacific--Sarah developed east of Leyte on the 16th. She moved north-northwestward and intensified despite passing through the Philippines. On the 18th Sarah turned westward and traveled across Luzon, north of Manila. By this time she was generating winds of 40 kn. Sarah reached typhoon strength on the 20th as 75-kn winds roared around her center, which was located just 120 mi southeast of Hainan. The Panamanian TOPAZ ISLANDS (8,998 tons) grounded at Lamma Island, Hong Kong, with vast bottom damage. Sarah headed northwestward and crossed that island later in the day. However, the land took its toll, and Sarah dropped to tropical storm intensity before crashing ashore over north Vietnam on the 21st. In the Philippines Sarah was responsible for 10 deaths, including 8 people who drowned when a boat sank.

While Sarah was skimming across the Gulf of Tonkin, Thelma was coming to life in the Philippine Sea near 15°N, 130°E. Moving west-northwestward, Thelma reached typhoon strength on the 23d shortly before clipping northeastern Luzon. Winds were up to 80 kn near her center. The KAKUHO MARU reported roaring 80-kn winds and 20-ft waves northwest of the center. Thelma turned northward on the 24th, and winds increased to 85 kn with gusts to 105 kn as the typhoon approached southern Taiwan. The PRESIDENT MCKINLEY was about 70 mi northeast of the eye at 1800 with 45-kn winds and 20-ft seas and swells. The ERIKA BOLTEN (21°N, 122°E) was northeast of the eye and reported 37-kn winds and 16-ft waves. Thelma brought her strong winds and torrential rains to the west coast of Taiwan on the 25th. The PRESIDENT MCKINLEY was off the southern tip of Taiwan at 0000 fighting 70-kn winds and 25-ft seas. The rains continued for several days as she made her way across the Formosa Strait and into mainland China. Four rivers swelled by the downpours flooded southern Taiwan, inundating buildings and farmlands and driving more than 10,000 people to their rooftops. At least four people drowned in the worst flood in more than 3 decades.

The port of Kaohsiung was destroyed (fig. 45). About 800 power poles were broken. All eight of its container-handling cranes were demolished. The Harbor Bureau had to forbid any container ships without onboard cranes from entering the harbor. In addition to the cranes, 32 vessels were sunk. These included the 3,316-ton CHENG LUNG and the 4,791-ton LUCKY 1. The U.S. tanker GAINES MILL capsized and grounded near the port. The vessel was in tow from California to Taiwan for breakup. Also, the FRESNO CITY was reported to have sustained serious damage in the harbor. The PRESIDENT LINCOLN found 50-kn winds and 20-ft waves over the southern Formosa Strait at 0000 on the 26th, after Thelma had penetrated main-

Figure 45.--Thelma left power poles hanging in the air by their lines, light standards broken, and many buildings and homes destroyed. It was one of the worst to strike Taiwan in 30 yr. Wide World Photo.

land China.

Typhoon Vera formed north of the normal area of development. She was spotted about 150 mi southeast of Okinawa on the 28th. Vera moved west-southwestward and intensified to typhoon strength by early on the 29th. At 0000 the ZUIHO MARU fought 45-kn easterly winds and 15-ft waves 60 mi northeast of the eye. After dipping slightly southward the typhoon turned to the west-northwest and took aim on northern Taiwan. At 0000 on the 30th the PORT LATTA MARU was within 40 mi of the center with 45-kn winds, 25-ft waves, thunderstorms, and a pressure of 990 mb. By the 31st winds near her center were blowing at 110 kn with gusts to 135 kn. Vera brought her destructive act to the northern part of the island later that same day. Winds blew down houses, while rains caused numerous mudslides. The death toll stands at 38, including 5 people who were crushed when winds collapsed a steel bridge support in downtown Taipei. The support, which was designed to hold up a footbridge being built over a street, fell and smashed five vehicles including two buses (fig. 46). At the port of Keelung three of the four dockside container-handling cranes were damaged or destroyed. However, timely warnings and the occurrence of Thelma a week before prompted most ships to put to sea to ride out the storm.

Three Japanese islands in the Ryukyu group east of Taiwan were hard hit. Almost all power and telephone lines were knocked down by recorded 135-kn winds; the barometer reading was 925 mb. The typhoon destroyed 131 homes and damaged 1,063 others. Two ships sank, 10 went aground, 3 were washed away, and 22 were damaged. Three people died and three others were missing from the sunken ships. Crops were also heavily damaged.

Figure 46.--An overhead steel bridge in downtown Taipei collapsed on this bus. Five persons were killed and nine injured when it smashed two buses, two taxi cabs, and a car. Wide World Photo.

On the last day of the month tropical storm Wanda flared up just south of Iwo Jima. She moved northward and reached a 45-kn peak on August 1 about 60 mi west of Chichi Jima. That same day Wanda fell to depres-

sion strength. She turned toward the northeast, briefly regained tropical storm intensity on the 3d, but then dissipated the following day.

Casualties--Dense fog caused seven ship collisions in Japanese waters on the 2d. The 2,988-ton KURENAI MARU and the 508-ton IL SHIN HO collided in 500-m visibility while both were sounding alarm whistles. The 986-ton RAKUSHO MARU and the 199-ton ICHIYO MARU, both tankers, collided near Yashima Island. Near the same island, the 999-ton WA PYONG CHUNG MUG and the 179-ton FUEI MARU collided. After daylight the Liberian-registered freighters HUGH EVERETT (5,822 tons) and the THOMAS EVERETT collided off Kobe lighthouse. In the Tokai region the 1,512-ton NIPPO MARU NO. 76 and 491-ton SANEI MARU No. 1 collided. Later in the morning the 424-ton TOKO MARU No. 8 hit the SANEI MARU No. 1. There was no serious damage to the three vessels. At the mouth of Tokyo Bay the 8,900-ton Greek freighter ASSOMATOS collided with the 498-ton EIFUKU MARU No. 7.

The 16,518-ton American PRESIDENT TRUMAN was struck by the American EXPORT BUILDER (7,939 tons) in Pusan Outer Roads in dense fog on the 4th. On the 5th the 499-ton DAIYU MARU No. 8 and the 499-ton WASASHU MARU No. 18 collided in heavy fog. The DAIYU MARU sank with two crewmen missing. The 24,027-ton TRINITY MARINER was surveyed at Keelung for heavy weather damage on July 5 and 8. The Japanese car ferry KAWANOE (2,886 tons) and the South Korean container ship VENUS (1,998 tons) collided on the fog-shrouded Inland Sea early on the 12th. The AUSTRAL ENDURANCE encountered heavy weather on the 24th and lost 27 containers overboard on a voyage from New York to Sydney. The 1,258-ton MEIHO MARU sank near 34°N, 126.6°E, after a collision with the 11,538-ton NORLANDA in fog on the 30th. One crewman died.

SMOOTH LOG, AUGUST 1977--There appeared to be very little rhyme or reason to the storm paths this month. The only area where there was a semblance of concentration to be referred to as a path was from interior Siberia into the East Siberian Sea. Cyclones in the vicinity of Japan tended to move northward. Storms over the central ocean and Bering Sea each had their own orientation. No storm center disturbed the northern part of the Gulf of Alaska. They dissipated or turned northwestward prior to entering the Gulf. Climatology indicates three primary tracks--from the Sea of Okhotsk into the Bering Sea, Japan into the Bering Sea, and the north central ocean into the Gulf of Alaska.

Only the basic circulation centers of the mean sea-level pressure analysis matched climatology. The 1007-mb Aleutian Low was centered east of Kamchatka near its 1008-mb climatic counterpart. The 1023-mb Pacific High was near 34°N, 143°W, about 500 mi southeast of its 1024-mb climatic position. A secondary 1008-mb LOW was centered over Unimak Island. This produced a deep trough in the center of the Pacific High giving it a waterwing rather than an egg-shaped configuration. This resulted in a large minus 9-mb anomaly center over the central ocean. A sharp ridge extended from the center of the HIGH to the southeastern coast of Alaska, giving an indication of why few storms penetrated that area. The Pacific High also extended further west than normal, resulting in an area of positive anomaly 20° longitude wide southeast of Kamchatka. There was an anomalous 1005-mb LOW east of Kyushu with a resulting 5-mb anomaly center.

The upper air pattern also differed radically from climatology. The LOW at 700 mb was centered near the Fox Islands (54°N, 170°W). Again, a sharp trough dipped into the HIGH dividing it into two centers, with a sharp ridge off the Canadian west coast extending well into the Beaufort Sea.

There were two tropical cyclones, hurricane Doreen over the eastern Pacific and tropical storm Amy over the western Pacific.

Extratropical Cyclones--During the first half of the month, a high-pressure cell was well entrenched over the central ocean near 40°N, 180°. It began at 1028 mb and built to a high of 1032 mb by the end of the first week. By the middle of the month, it was 1025 mb near 35°N, 165°E, and breaking down. LOWs that approached from south and west were diverted northward and/or dissipated. One of these was the extratropical remains of tropical storm Wanda. This relatively weak LOW (about 998 mb) had persisted near 33°N, 150°E, for over a day. On the 5th a 997-mb LOW crossed Japan, and the northern part of Honshu was flooded by heavy rains of up to 1 ft. Seven persons were killed and four missing after flash floods. About 5,000 families had to evacuate their homes. Roads were damaged, bridges washed away, and landslides contributed to the misery. The PLUTO at 43°N, 160°E, suffered 44-kn gales. The MAINE was near the remains of Wanda and found 48-kn winds and 25-ft swells. On the 7th the two centers combined into one 996-mb center which rolled northward along the 152°E meridian. The gradient between the two centers tightened, and with the steady southerly winds and long fetch, the OJI MARU was hit by 25-ft swells near 47°N, 166°E, at 1200. Other ships in the area had gales and seas and swells up to 20 ft.

A frontal wave developed over China and moved over the Sea of Japan on the 7th. On the 0000 chart of the 9th it was 990 mb over Hokkaido. At that time the MEDARIANA (35°N, 142°E) was blasted by 60-kn southwesterly winds just east of the cold front. The PRESIDENT PIERCE (40°N, 147°E) had 45-kn gales, and several other ships reported lighter gales in the area. The HIGH over the central ocean turned the storm northward over the Sea of Okhotsk on the 10th.

This was strictly a Bering Sea storm. The center looped counterclockwise over the center of the Sea. The LOW formed at a point of occlusion near 56°N, 171°E, on the 14th. The LOW moved as far east as the 180° meridian, where it paused for 24 hr before turning back westward on the 16th. At 0000 the center was 993 mb. The ASIA BOTAN, a good reporter, was headed into 50-kn westerly winds about 300 mi south of the center. On the 18th the LOW dissipated.

The persistent HIGH was breaking down by the middle of the month, and a wave formed on a weak front near 45°N, 160°E, on the 18th. It raced east-southeastward

under zonal flow. Ships east and west of the center were reporting moderate to heavy rain. The LOW passed north of the ORIENTAL EDUCATOR treating her to 35-kn gales.

On the 19th the LOW started deepening as it turned northeastward. On the 20th, the LOW was 986 mb near 46°N, 167°W. The HOLLAND MARU was less than 200 mi southwest of the center with 40-kn winds and waves of 12 ft. On the 21st, the OJI MARU had 43-kn northeasterlies. The AMSTELHOF was at least 400 mi south of the LOW with 20-ft swells. The LOW passed very close to two ships at 1200 on the 21st. The LOW was analyzed as 981 mb, and the ships registered 985 mb on their barometers. The KOULOUNDA had 50-kn winds with 20-ft seas, and the UZBEKISTAN had 52 kn with no seas indicated.

On the 21st the LOW started turning westward, and a frontal wave moved eastward south of the LOW. The LOW continued to circle southward and completed the loop by the 25th and was moving northeastward again. During that time the LOW filled and weakened with a much smaller circulation. The JAPAN RAINBOW was southeast of the LOW that moved around the periphery with 40-kn gales and 34-ft swells. The original LOW continued northeastward to dissipate near Kodiak Island on the 27th.

A frontal wave formed off Japan on the 19th and split into two LOWs on the 21st. The eastern one survived. On the 22d the PICA was north of the center and sailing into 45-kn easterly winds. Along the warm front a ship reported 16-ft seas and 20-ft swells. As this LOW passed south of the one described above, several ships reported gales. It was with this LOW that the JAPAN RAINBOW found the 34-ft swells on the 24th. The lowest pressure was 990 mb on the 24th. The JAPAN RAINBOW was headed eastward along with the storm and at 0000 on the 25th had 40-kn winds with the swells remaining at 34 ft. Later in the day the LOW disappeared.

This frontal wave started on the 21st south of Japan on a front that stretched into former tropical storm Amy. At 0600 on the 22d, the SUENDBORG MAERSK, near 30°N, 139°E, had 20-ft seas and 33-ft swells. At this time the LOW was labeled a tropical depression, but on the 23d a cold front developed. The JLJL was near the front at 30°N, 141°E, with 40-kn winds and 15-ft waves. On the 24th the INACHUS STAR was 400 mi west of the 988-mb center with 40-kn winds and 23-ft swells. The ROSE was east of the center measuring 45-kn winds and 33-ft swells. On the 25th the swells were 25 ft, but the winds had decreased. The INACHUS STAR was following the storm, and on the 26th the swells had increased to 26 ft. The UNIQUE FORTUNE was also west of the 992-mb center with 20-ft swells.

The LOW had shifted to a southeasterly direction with the INACHUS STAR still calling the swell waves 25 ft at 1200. By the 27th the LOW had turned southward and then westward. It had weakened considerably, and there were three centers in a weak pressure area. Late on the 28th, no circulation center could be found.

Tropical Cyclones, Eastern Pacific--Doreen was the second tropical cyclone within a year to bring heavy rains to southern California. She began as a tropical disturbance 100 mi west of Acapulco, Mexico, at 0000 on the 11th. Ship reports along the Mexican coast helped to locate the disturbance with those south of Acapulco reporting southeasterly winds and those north of Acapulco reporting northwesterly winds. Drifting west at 6 kn, the disturbance was upgraded to a tropical depression at 0000 on the 13th about 400 mi west of Acapulco. The cyclone then turned northwestward and began to slowly intensify over 82°F water. By 1800 winds near the center had increased to 45 kn.

Twenty-four hours later Air Force reconnaissance had located the center of Doreen 160 mi south of the tip of Baja California. Based on extrapolated sea-level pressure (979 mb), the storm was upgraded to a hurricane with 65-kn winds near the center. The eye, open to the southwest, was 15 mi in diameter.

Turning toward the north-northwest and increasing her speed to 9 kn, Doreen passed 30 mi west of the tip of Baja California early on the 15th. She then turned northwestward and, moving at 18 kn, touched onshore briefly near San Carlos on the west coast of southern Baja. The EXPORT BUYER, southeast of the center at 2100, had 60-kn winds, 20-ft seas, and 25-ft swells. The winds decreased to 35 kn by 2400, but the seas held at 25 ft. Doreen moved northwestward over cooler 72°F water and weakened. By the 16th winds near the center had decreased to 50 kn, and the hurricane was downgraded to a tropical storm near 26.4°N, 113.2°W. Drifting onshore again, Doreen moved to the tip of the Point Eugenia Peninsula, then offshore over the Bay of Sebastian Vizcaino. Winds near the center had decreased to 35 kn over water that was now near 68°F.

Winds continued to decrease as Doreen drifted toward the southern California coast. By 0600 on the 17th, with winds near 30 kn, she was downgraded to a tropical depression 130 mi south of San Diego. With satellite imagery showing weak low-level cyclonic circulation, the final advisory was issued at 1800 with the center 25 mi north-northwest of San Clemente Island off the southern California coast. Remnants of Doreen then drifted slowly northeastward across southern California.

While Doreen was off the central Mexican coast and still south of Baja California, another disturbance developing near 15°N, 119°W, began to drift eastward into the cyclonic flow associated with Doreen. Ships within 300 mi of this new disturbance reported moderate to heavy rain. As Doreen moved northward along the Baja California coast, this moisture was carried northward around Doreen and into southern California. This moist tropical air began to enhance shower and thundershower activity over the southern California desert areas on the 15th. Flash flood watches and warnings already in effect for heavy thundershowers over the Colorado River Valley and eastern desert areas were extended with heavy rain warnings to most of southern California by the 16th.

Rain moving northward with Doreen reached San Diego early on August 16, spreading northward to the Los Angeles basin and Mojave Desert by afternoon and Owens Valley and southern San Joaquin Valley by evening. On the coast rain spread as far north as Santa Barbara by early the next morning. Rain continued over southern California through late evening on the 17th, and a few lingering showers remained in

the Los Angeles area until late the following morning. An average of 2 to 4 in of rain fell over the low-lying areas of southern California during the 3-day period, and as much as 7.5 in in the higher mountains. A total of 2.13 in of rain fell at San Diego airport, 3.78 in at Calexico, 3.87 in at Imperial, 2.47 in at Los Angeles airport, 3.14 in at Santa Monica, 2.61 in at Mt. Wilson near Los Angeles, and 7.45 in at Mt. San Jacinto west of Palm Springs. Unusually heavy rain fell at Mitchell Caverns 60 mi west of Needles, where 6 in was reported on the 17th.

There were no deaths in the United States directly attributable to Doreen, but five deaths were indirectly attributed to the heavy rains and flooding. Damage was extensive, particularly to agricultural interests in the Imperial and San Diego counties. Losses are estimated in excess of $25 million. Flood waters destroyed 325 homes and businesses in the southern desert areas, and several people were evacuated from low-lying areas. The small desert town of Ocotillo was flooded again as it had been during hurricane Kathleen in September 1976. Buses sent to evacuate people from Ocotillo returned empty, however, when the townspeople declined to leave their small community. Interstate Highway 8 at Myers Creek, west of Ocotillo, was washed out again as it had been during Kathleen (fig. 47). Although floodwaters were less than with Kathleen, boulders the size of small cars were observed moving down Interstate Highway 15 between Los Angeles and Las Vegas, and floodwaters carried away two of the four lanes.

Figure 47.--One of the highways washed out by the heavy rains of Doreen. Los Angeles Times Photo.

Tropical Cyclones, Western Pacific--Amy, the region's only tropical cyclone this month, formed in the Luzon Strait on the 20th. Moving westward, she quickly reached tropical storm strength later in the day. Winds near the center climbed to just 35 kn and then slackened early the next day. As a depression, Amy moved northeastward past the east coast of Taiwan on the 22d. The 2,152-ton CHAPTAL ran aground near 22.6°N, 120.2°E, during this typhoon. Deck cargo was adrift, and the No. 1 hold and engineroom were flooded when she was abandoned by the crew. Amy reintensified in the East China Sea. On the 24th she moved across Kyushu, near Nagasaki. Winds of 50 kn blew around her 985-mb center. Heavy downpours lashed western Japan with total storm amounts of up to 20 in, as Amy fell to depression strength and stagnated off Shikoku.

Casualties--The barge MLC 25 in tow of the tug PETER W. bound for Dutch Harbor from Seattle encountered heavy weather 2 days out of Sand Point, Alaska. The cargo of construction material was damaged. The 6,460-ton Iranian ARYA OMID enroute to Yokohama from the Persian Gulf reported heavy weather damage.

The 1,119-ton barge L-2600 capsized in rough seas on the 6th while in tow of the tug VIKING and sank near 11.9°N, 114.7°E, on the 11th. The nonpropelled dredge BIDDLE while under tow and the 14,113-ton HAWAIIAN collided in heavy fog at the mouth of the Columbia on the 9th (fig. 48). The BIDDLE sustained heavy damage with partial flooding. The HAWAIIAN proceeded.

Figure 48.--The 315-ft Army Corps of Engineers dredge BIDDLE collided in thick fog with the containership HAWAIIAN at the mouth of the Columbia River near Astoria. Wide World Photo.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

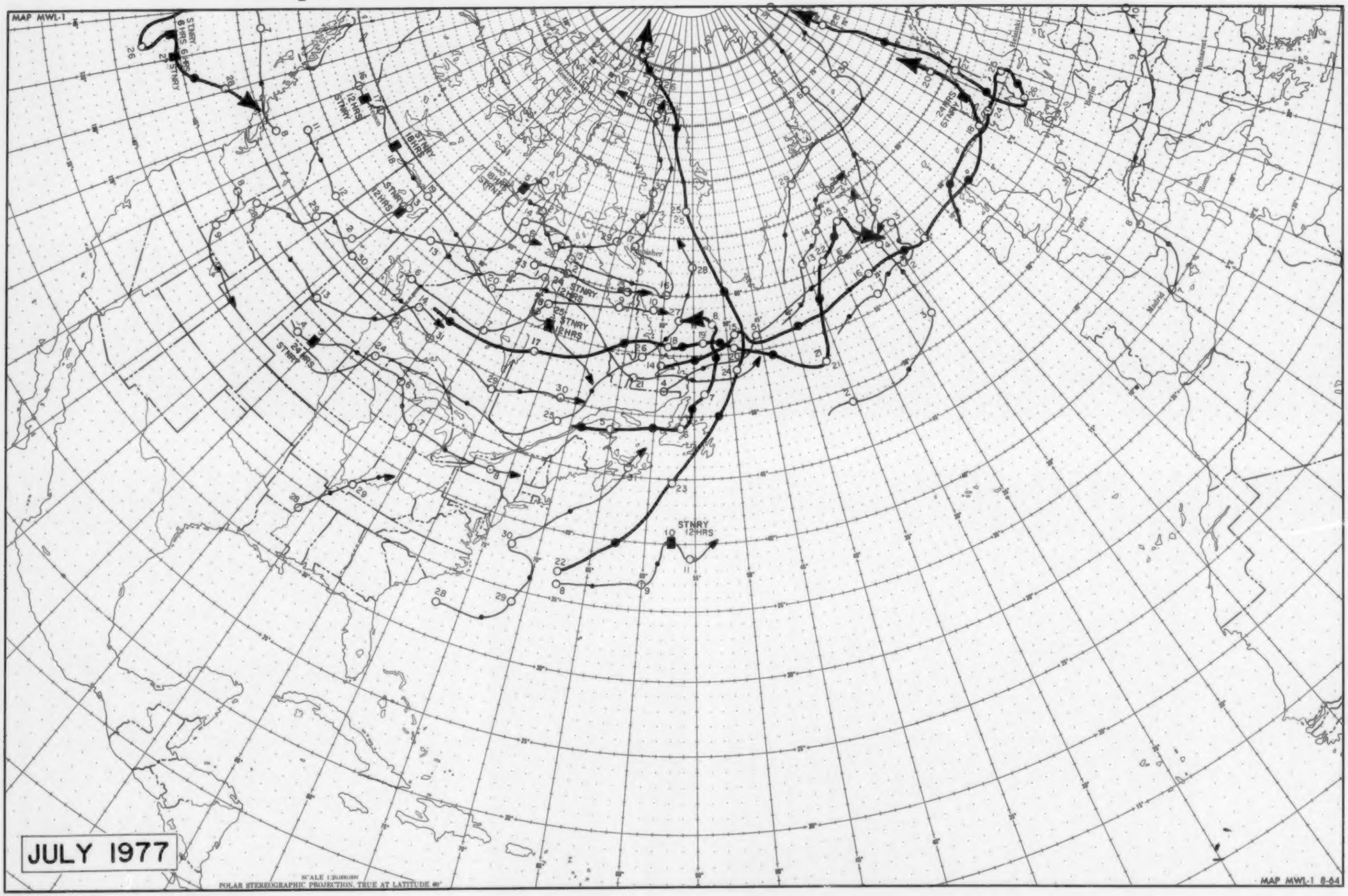


Figure 49. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

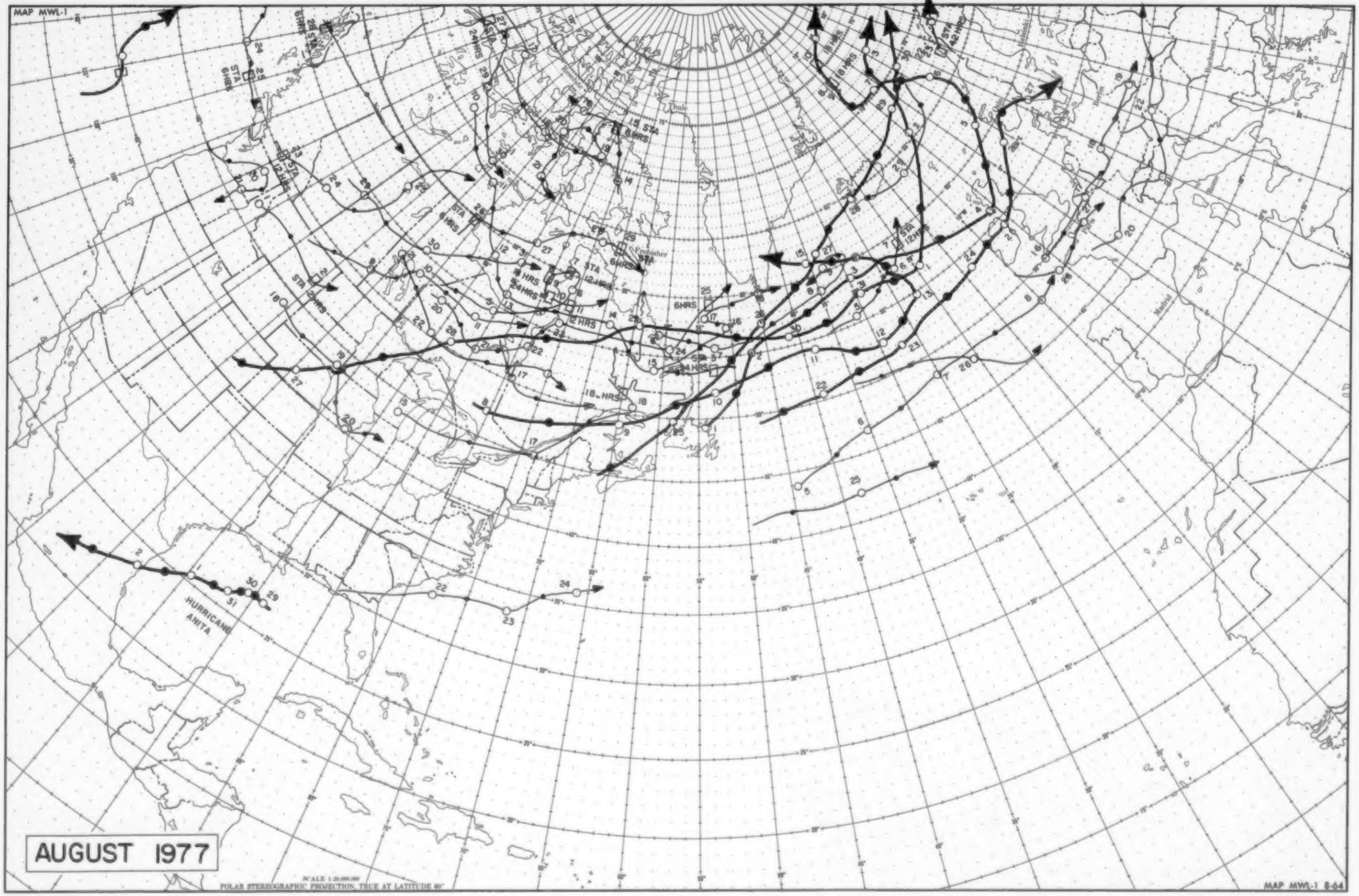


Figure 50. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

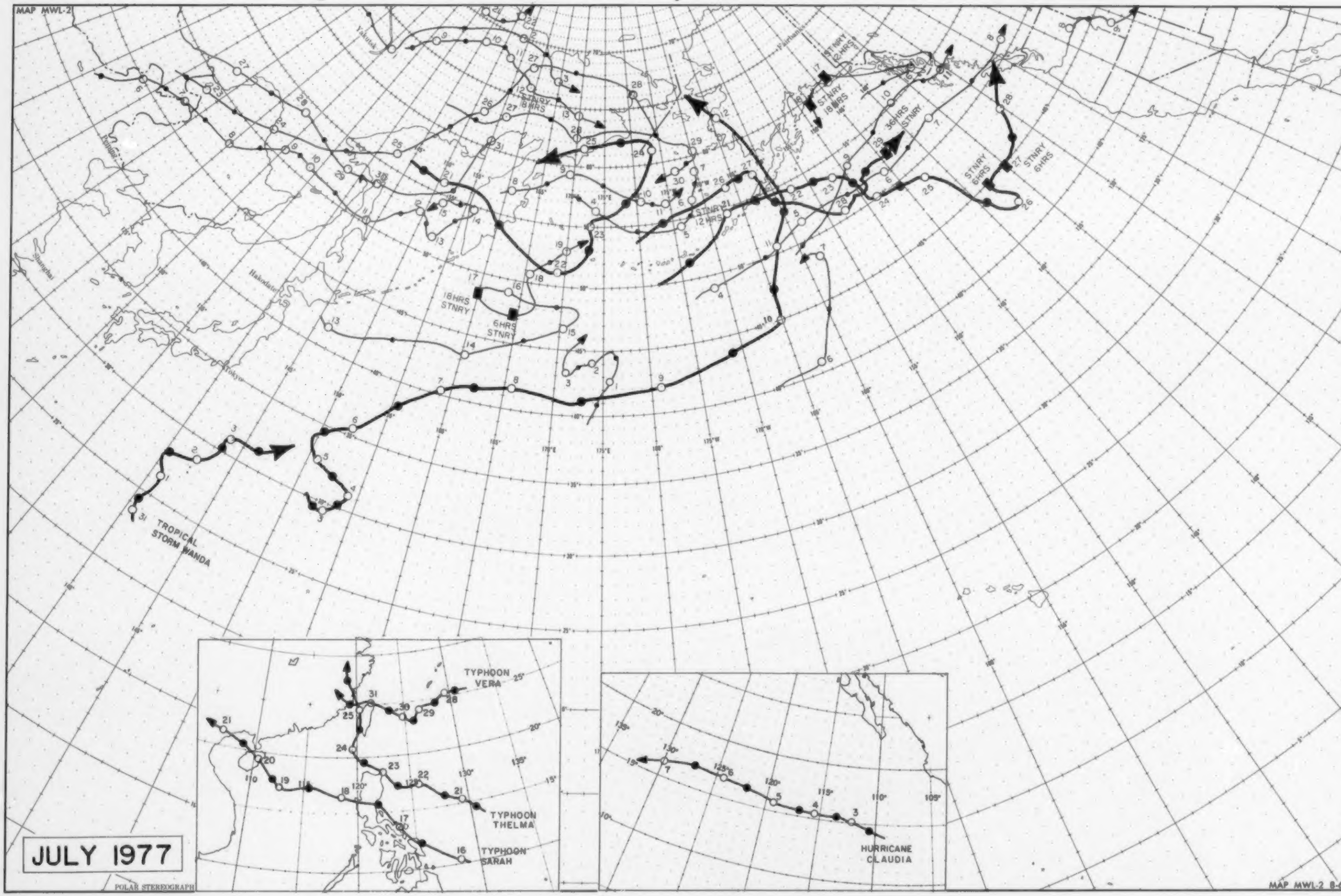


Figure 51.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

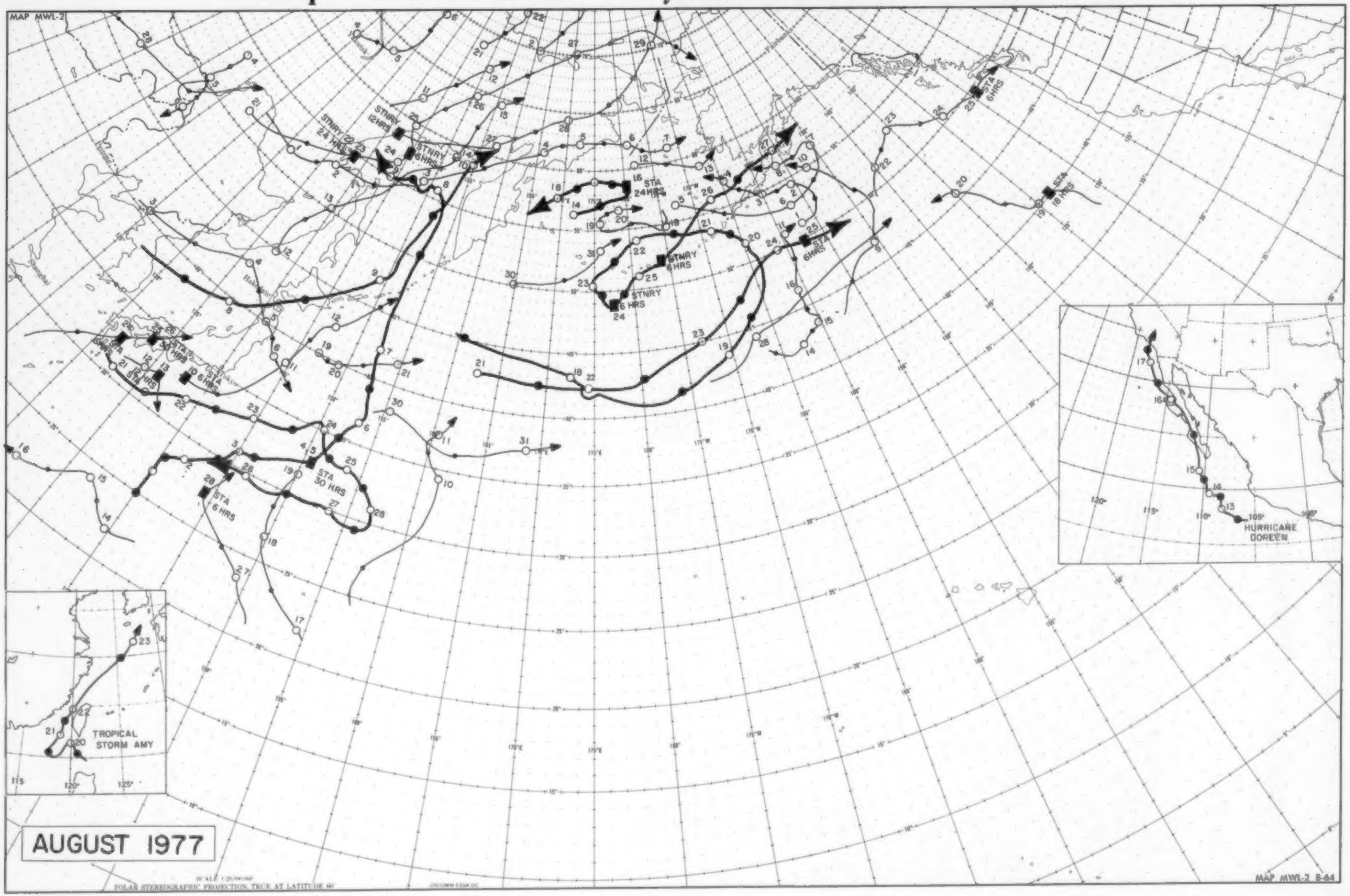


Figure 52. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Table 4
U. S. Ocean Weather Station Climatological Data
August and September 1977

Ocean Weather Station 'HOTEL' 38°00'N 71°00'W — **August and September, 1977**

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
AUG	21.3	28 06	26.1	29.1	10 21	12.5	26 06	21.4	25.8	*09 09	25.1	27 21	27.4	29.6	05 18	- 3.2	*22 03	- 1.3	1.0	13 12
SEPT	17.9	22 09	23.3	27.8	06 18	8.8	30 09	18.6	24.1	06 18	22.7	30 12	25.0	28.0	03 18	- 6.2	30 18	- 1.7	1.3	20 18

MONTH	MEANS AND EXTREMES: PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS): TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER: PCPN	RAIN OR DRZL	SNOW	TSTM	VERY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
AUG	1011.1	25 06	1019.8	1029.4	28 15	34.9	31.0	21.4	12.7	72.9	21.0	4.4	1.7	12	12	0	4	0	3	0	0	28	6.1	229
SEPT	1005.7	*28 18	1017.4	1030.6	*16 15	31.6	25.6	27.4	15.3	64.2	22.3	9.8	3.7	15	12	0	1	0	0	0	0	17	6.2	215

** VV-90-93 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

AUG WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.8	2.7	3.4	.8	.0	.0	7.6	12.2
NE	1.4	4.7	3.8	1.9	.0	.0	11.8	12.0
E	.4	3.4	1.4	.0	.0	.0	5.2	7.1
SE	.5	3.8	.1	.0	.0	.0	4.5	5.0
S	1.5	7.4	1.9	.0	.0	.0	10.9	6.9
SW	1.0	7.6	16.5	6.1	.9	.0	32.1	15.6
W	1.5	4.4	12.3	3.1	.0	.0	21.3	14.5
NW	.7	1.7	1.5	.0	.0	.0	3.9	8.9
CALM	3.1	.0	.0	.0	.0	.0	3.1	.0
TOTAL	10.9	35.8	40.6	11.8	.9	.0	100.0	12.1

NUMBER OF OBS 229 — MAX WIND: DIR 235, SPEED 44, DA HR 15 0724 — VECTOR SPEED 6.1 — MEAN DIR 247 (DIR IN DEGREES)

SEPT WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	2.4	7.8	4.9	.8	.0	.0	19.9	11.7
NE	1.5	5.1	9.1	.9	.0	.0	18.7	11.5
E	.9	3.7	1.4	.0	.0	.0	5.8	9.0
SE	.7	3.1	3.5	.1	.0	.0	7.4	10.7
S	1.6	4.9	3.5	.8	.0	.0	10.8	10.8
SW	.9	4.8	8.3	1.4	.0	.0	15.3	13.3
W	.9	9.0	5.2	.5	.0	.0	15.1	10.7
NW	.2	4.4	5.9	2.4	.0	.0	12.9	14.6
CALM	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	8.6	42.8	41.9	7.0	.0	.0	100.0	11.8

NUMBER OF OBS 215 — MAX WIND: DIR 350, SPEED 31, DA HR 15 0500 — VECTOR SPEED 2.5 — MEAN DIR 305 (DIR IN DEGREES)

Wave

AUG WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	4.6	3.8	.3	.0	.0	.0	.0	8.7
NE	.0	4.7	2.3	.1	.0	.0	.0	.0	7.1
E	.0	4.7	.0	.0	.0	.0	.0	.0	4.7
SE	.4	7.4	.0	.0	.0	.0	.0	.0	7.9
S	.8	15.2	1.8	.0	.0	.0	.0	.0	17.6
SW	2.2	20.0	3.6	2.2	.0	.0	.0	.0	27.9
W	4.5	13.8	.0	.0	.0	.0	.0	.0	18.2
NW	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	1.3	6.1	.0	.0	.0	.0	.0	.0	7.4
CALM	.4	.0	.0	.0	.0	.0	.0	.0	.4
TOTAL	9.6	76.4	11.4	2.6	.0	.0	.0	.0	100.0

NUMBER OF OBS 229 — IND=INDETERMINATE

SEPT WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.5	8.5	5.6	.0	.0	.0	.0	.0	14.9
NE	.5	11.5	4.5	1.9	.0	.0	.0	.0	18.4
E	.0	2.1	2.0	.0	.0	.0	.0	.0	4.1
SE	.3	4.4	.7	.0	.0	.0	.0	.0	5.4
S	2.6	7.0	1.3	.8	.0	.0	.0	.0	11.6
SW	7.0	11.6	3.7	.2	.0	.0	.0	.0	22.6
W	2.9	4.9	.9	.3	.0	.0	.0	.0	9.1
NW	.6	4.0	1.3	1.9	.0	.0	.0	.0	7.7
IND	.3	6.0	.0	.0	.0	.0	.0	.0	6.5
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	14.9	60.0	20.0	5.1	.0	.0	.0	.0	100.0

NUMBER OF OBS 215 — IND=INDETERMINATE

AUG WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	6.1	35.4	4.4	.0	.0	.0	.0	.0	45.9
6-7	2.2	34.9	7.0	2.6	.0	.0	.0	.0	46.7
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	1.3	6.1	.0	.0	.0	.0	.0	.0	7.4
TOTAL	9.6	76.4	11.4	2.6	.0	.0	.0	.0	100.0

NUMBER OF OBS 229 — MAX WAVE HEIGHT: HGT 3.5, PER 6, DIR 230, TYPE SEA, DA HR 18 03 — IND=INDETERMINATE (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

SEPT WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	9.8	22.3	7.0	3.3	.0	.0	.0	.0	42.3
6-7	4.7	29.3	9.3	.5	.0	.0	.0	.0	43.7
8-9	.0	2.3	3.3	1.4	.0	.0	.0	.0	7.0
10-11	.0	.0	.5	.0	.0	.0	.0	.0	.5
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.5	6.0	.0	.0	.0	.0	.0	.0	6.5
TOTAL	14.9	60.0	20.0	5.1	.0	.0	.0	.0	100.0

NUMBER OF OBS 215 — MAX WAVE HEIGHT: HGT 3.0, PER 6, DIR 040, TYPE SEA, DA HR 08 15 — IND=INDETERMINATE (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 5
U. S. Ocean Buoy Climatological Data
July and August 1977

JULY — D A T A S U M M A R Y — EB01
AVERAGE LATITUDE 38.0N AVERAGE LONGITUDE 072.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	18.8	(27 21)	25.8	28.0	(16 21)	244	31
SEA TEMP (DEG C)	25.0	(30 00)	26.5	27.8	(08 00)	171	20
AIR-SEA TEMP (DEG C)	-04.1	(27 15)	-00.4	03.4	(10 15)	170	20
PRESSURE (MBAR)	1008.8	(22 08)	1018.0	1024.3	(17 15)	245	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 212

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		1.4	.9	.9			3.3	15.1
NE		3.8	1.9				5.7	11.1
E	.5	3.3	2.8				6.6	9.6
SE	1.4	1.9	4.7				8.0	10.0
S	1.4	6.6	.9				8.0	8.1
SW	.9	12.7	28.3	4.7			46.7	15.8
W	.5	4.2	10.8	.5			16.0	13.8
NW	.9	.9	.5	.5			2.8	8.7
CALM	1.9						1.9	.0
TOTAL	7.1	34.0	51.4	6.6			100.0	12.3

MAX WIND — SPEED: 28 KNOTS; DIRECTION: 240 DEG; DAY: 22; HOUR: 00

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 240

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY		87.9	12.1						1.5M	2.5M	(25 15)

AUGUST — D A T A S U M M A R Y — EB01
AVERAGE LATITUDE 35.0N AVERAGE LONGITUDE 072.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	24.0	(25 12)	26.3	27.8	(14 21)	247	31
SEA TEMP (DEG C)	25.0	(27 08)	26.5	27.4	(16 00)	148	20
AIR-SEA TEMP (DEG C)	-03.2	(25 12)	-00.4	03.1	(15 03)	148	20
PRESSURE (MBAR)	1011.8	(20 08)	1020.0	1028.8	(28 15)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 78

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N								
NE			3.8				3.8	15.0
E								
SE	1.3						1.3	3.0
S		3.8	6.4				10.3	12.5
SW		23.1	53.8	2.6			79.5	13.8
W		2.6	2.6				5.1	13.0
NW								
CALM								
TOTAL	1.3	29.5	66.7	2.6			100.0	13.5

MAX WIND — SPEED: 23 KNOTS; DIRECTION: 210 DEG; DAY: 03; HOUR: 00

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 240

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	5.0	86.3	8.8						1.2M	2.5M	(29 15)

JULY — D A T A S U M M A R Y — EB03
AVERAGE LATITUDE 56.0N AVERAGE LONGITUDE 147.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.0	(15 03)	11.4	13.2	(11 03)	244	31
SEA TEMP (DEG C)	10.0	(01 15)	11.6	12.7	(21 03)	243	31
AIR-SEA TEMP (DEG C)	-02.6	(15 09)	-00.2	01.3	(02 18)	242	31
PRESSURE (MBAR)	1005.7	(15 18)	1014.3	1024.8	(08 06)	245	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 244

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		.8	1.6				2.5	12.4
NE		1.2	1.6				2.8	11.4
E	.8	5.7	18.4	1.2			26.2	13.8
SE		8.6	9.8	2.5			20.9	13.5
S		1.2	1.6	1.2			4.1	15.0
SW		5.7	4.1				9.8	10.8
W	.4	6.8	20.1	.4			27.9	13.2
NW		2.0	3.3	.4			5.7	13.1
CALM	.4						.4	.0
TOTAL	1.6	32.0	60.7	5.7			100.0	13.1

MAX WIND — SPEED: 28 KNOTS; DIRECTION: 190 DEG; DAY: 27; HOUR: 00

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 244

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY		82.8	15.2	2.0					1.4M	3.0M	(28 03)

AUGUST — D A T A S U M M A R Y — EB03
AVERAGE LATITUDE 56.0N AVERAGE LONGITUDE 147.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.8	(06 00)	11.8	15.1	(26 21)	243	31
SEA TEMP (DEG C)	11.0	(12 15)	11.8	13.5	(26 03)	245	31
AIR-SEA TEMP (DEG C)	-02.3	(20 06)	00.0	02.3	(26 00)	243	31
PRESSURE (MBAR)	0993.2	(08 03)	1014.8	1027.5	(16 18)	244	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 243

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	1.6	1.2				3.3	8.4
NE	.4	3.7	.8				4.9	7.4
E	.8	5.3	4.5	1.2			11.9	12.2
SE		2.9	16.5	8.6			28.0	18.1
S	1.6	11.1	8.6	.4			21.8	10.8
SW	1.2	9.1	.4				10.7	8.8
W	.4	4.5	7.8				12.8	10.6
NW	.8	2.9	2.1				5.8	8.7
CALM	.8						.8	.0
TOTAL	6.6	41.2	42.0	10.3			100.0	12.1

MAX WIND — SPEED: 32 KNOTS; DIRECTION: 130 DEG; DAY: 07; HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 244

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	.4	75.4	18.4	5.7					1.5M	3.5M	(10 18)

JULY — D A T A S U M M A R Y — EB04
AVERAGE LATITUDE 28.0N AVERAGE LONGITUDE 090.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	24.2	(17 18)	28.2	30.7	(31 00)	235	31
SEA TEMP (DEG C)	28.1	(17 18)	29.2	31.2	(24 21)	236	31
AIR-SEA TEMP (DEG C)	-03.8	(17 18)	-01.0	00.2	(24 00)	235	31
PRESSURE (MBAR)	1015.3	(27 00)	1018.8	1022.1	(01 18)	235	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 237

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.7	3.4					5.1	4.3
NE	1.7	5.6	2.1				9.7	7.7
E	4.6	24.5	8.9				38.0	8.0
SE	3.4	15.2	2.1				20.7	6.6
S	2.1	11.0					13.1	5.8
SW	1.3	2.1					3.4	4.8
W	1.3	3.4	.4				5.1	6.4
NW	.8	3.8	.4				5.1	6.5
CALM								
TOTAL	16.9	69.2	13.9				100.0	6.8

MAX WIND — SPEED: 21 KNOTS; DIRECTION: 070 DEG; DAY: 15; HOUR: 21

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 222

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	71.2	28.8							.8M	1.0M	(18 18)

AUGUST — D A T A S U M M A R Y — EB04
AVERAGE LATITUDE 28.0N AVERAGE LONGITUDE 090.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	23.3	(31 09)	28.2	30.0	(24 21)	245	31
SEA TEMP (DEG C)	28.1	(31 18)	29.6	30.8	(01 21)	249	31
AIR-SEA TEMP (DEG C)	-06.8	(30 18)	-01.4	00.1	(09 18)	246	31
PRESSURE (MBAR)	1004.8	(30 21)	1016.4	1021.5	(16 15)	243	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 246

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	2.4					2.8	5.6
NE	.8	2.0	.8				3.7	7.8
E	1.6	8.4	19.8	1.2			31.0	11.5
SE	2.0	13.6	9.8	1.2	1.2		28.9	11.4
S	3.7	11.4	3.3	1.2	.8		20.4	8.7
SW	1.2	4.9	.8	.4			7.3	8.4
W	1.2	2.8	1.2				5.3	6.7
NW	.8	.8	.4				2.0	8.0
CALM	.4						.4	.0
TOTAL	12.2	47.3	34.3	4.1	2.0		100.0	10.2

MAX WIND — SPEED: 48 KNOTS; DIRECTION: 140 DEG; DAY: 30; HOUR: 21

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 234

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	54.7	38.9	.9	1.7	3.4				1.0M	5.5M	(30 21)

JULY — D A T A S U M M A R Y — EB05
AVERAGE LATITUDE 30.4N AVERAGE LONGITUDE 088.1W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	25.5	(31 00)	27.7	30.0	(11 21)	229	31
SEA TEMP (DEG C)	27.0	(30 18)	28.7	30.0	(12 21)	227	31
AIR-SEA TEMP (DEG C)	-03.5	(31 00)	-01.1	01.3	(11 21)	225	31
PRESSURE (MBAR)	1015.3	(07 08)	1018.8	1023.5	(04 15)	227	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 226

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	1.3	.4				2.2	7.6
NE	.9	.9	1.3				3.1	8.7
E	2.7	11.1	8.6				22.4	8.7
SE		7.1	1.3				8.4	8.1
S	.9	9.7	13.3				23.9	11.4
SW	1.3	11.5	13.3				26.1	10.1
W	.9	8.0	4.4				13.3	8.4
NW	.9	1.8					2.7	5.2
CALM								
TOTAL	8.0	51.3	40.7				100.0	9.5

MAX WIND — SPEED: 28 KNOTS; DIRECTION: 180 DEG; DAY: 27; HOUR: 03

AUGUST — D A T A S U M M A R Y — EB05
AVERAGE LATITUDE 30.4N AVERAGE LONGITUDE 088.1W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	23.8	(13 03)	27.7	28.4	(08 18)	231	31
SEA TEMP (DEG C)	26.4	(31 15)	28.4	30.5	(23 18)	231	31
AIR-SEA TEMP (DEG C)	-05.5	(13 03)	-00.8	01.6	(31 15)	231	31
PRESSURE (MBAR)	1012.1	(22 00)	1016.6	1024.0	(28 15)	228	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 230

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N								
NE								
E	1.3	14.8	15.2				31.4	10.8
SE		15.3	5.7	.4			21.4	9.1
S	1.7	7.4	13.1				22.3	11.2
SW	.9	3.5	12.7	.9			17.9	13.0
W	.9	.4	3.9				5.2	12.7
NW	.4	.9	.4				1.7	7.5
CALM								
TOTAL	5.2	41.5	52.0	1.3			100.0	10.8

MAX WIND — SPEED: 34 KNOTS; DIRECTION: 150 DEG; DAY: 12; HOUR: 18

JULY — DATA SUMMARY — EB15

AVERAGE LATITUDE 32.5N — AVERAGE LONGITUDE 079.3W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	22.6	(03 18)	26.4	30.5	(14 18)	247	31
SEA TEMP (DEG C)	26.4	(05 12)	27.8	29.2	(16 21)	247	31
AIR-SEA TEMP (DEG C)	-09.1	(30 18)	-01.3	02.4	(14 18)	247	31
PRESSURE (MBAR)	1013.3	(22 21)	1018.3	1023.8	(17 15)	245	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 245

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	1.2	.8				2.4	8.7
NE	.8	1.6	.8	.8			4.1	11.5
E	.8	6.1	4.5				11.4	10.0
SE	.4	6.1					6.5	7.1
S	.8	7.8	5.3				13.8	8.8
SW		8.6	35.1	2.8			46.5	14.6
W	.4	1.2	7.3	.4	.4		8.8	13.8
NW	.8	1.6	1.2				3.7	7.8
CALM	1.6						1.6	.0
TOTAL	6.1	34.3	55.1	4.1	.4		100.0	12.1

MAX WIND — SPEED: 36 KNOTS — DIRECTION: 280 DEG — DAY: 30 — HOUR: 18

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 248

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	31.5	66.5	2.0						.8M	2.0M	(28 12)

AUGUST — DATA SUMMARY — EB15

AVERAGE LATITUDE 32.3N — AVERAGE LONGITUDE 079.3W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	21.8	(19 15)	26.7	28.8	(07 15)	247	31
SEA TEMP (DEG C)	27.2	(28 12)	28.4	30.3	(11 21)	247	31
AIR-SEA TEMP (DEG C)	-08.4	(18 15)	-01.7	00.3	(07 12)	247	31
PRESSURE (MBAR)	1009.7	(22 21)	1020.5	1026.5	(28 15)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 247

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N								
NE	.8	2.0					2.8	4.4
E	2.8	12.1	6.6				21.5	8.4
SE	.4	5.7	2.8				8.9	8.8
S	2.0	10.1	17.0	.8			30.0	11.3
SW		7.7	15.4	2.0			25.1	13.1
W	.8	2.8	3.3	.8			7.7	12.0
NW		.8	1.6	.4			2.8	12.0
CALM	1.2						1.2	.0
TOTAL	8.1	41.3	46.6	4.0			100.0	10.7

MAX WIND — SPEED: 26 KNOTS — DIRECTION: 180 DEG — DAY: 22 — HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	25.1	73.3	1.6						1.0M	2.0M	(23 00)

JULY — DATA SUMMARY — EB17

AVERAGE LATITUDE 52.0N — AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.2	(05 03)	10.5	12.4	(28 03)	248	31
SEA TEMP (DEG C)	08.2	(01 21)	10.8	13.4	(29 03)	248	31
AIR-SEA TEMP (DEG C)	-01.5	(21 12)	-00.3	00.7	(24 21)	248	31
PRESSURE (MBAR)	0995.0	(23 03)	1013.8	1026.2	(01 00)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 243

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.2	2.5	3.3				7.0	10.1
NE	.4	.4	.4				1.2	9.3
E		.4	.8				1.2	10.0
SE		3.7	3.7	1.2			8.6	13.6
S		7.0	8.2	.8			16.0	11.8
SW	.4	5.8	12.3	.8			19.3	13.2
W	.4	6.6	26.3				33.3	14.2
NW	.8	6.2	5.3				12.3	9.2
CALM	.8						.8	.0
TOTAL	4.1	32.9	60.5	2.8			100.0	12.4

MAX WIND — SPEED: 29 KNOTS — DIRECTION: 120 DEG — DAY: 05 — HOUR: 00

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY		78.9	20.2	.8					1.4M	3.0M	(23 00)

AUGUST — DATA SUMMARY — EB17

AVERAGE LATITUDE 52.0N — AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	10.1	(27 12)	11.8	13.5	(30 21)	247	31
SEA TEMP (DEG C)	11.5	(07 18)	12.0	13.1	(31 06)	247	31
AIR-SEA TEMP (DEG C)	-01.7	(27 12)	-00.1	01.2	(17 09)	247	31
PRESSUAL (MBAR)	0994.6	(08 15)	1008.0	1024.5	(30 21)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 247

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	2.0	.8				3.2	7.4
NE	.8	4.5	1.2	.4			6.9	9.2
E		2.0	4.9	.8			7.7	13.2
SE		3.6	11.3	4.0			19.0	16.3
S		4.0	19.0	2.4			25.5	14.5
SW	.8	3.2	6.9				10.9	11.0
W	1.2	6.5	9.7	.4			17.8	11.3
NW	1.2	1.6	4.5				7.3	10.7
CALM	1.6						1.6	.0
TOTAL	6.1	27.5	58.3	8.1			100.0	12.7

MAX WIND — SPEED: 28 KNOTS — DIRECTION: 130 DEG — DAY: 20 — HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	2.0	61.9	34.4	1.6					1.8M	3.0M	(20 21)

JULY — DATA SUMMARY — EB18

AVERAGE LATITUDE 51.0N — AVERAGE LONGITUDE 136.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.4	(03 12)	10.8	12.8	(31 21)	247	31
SEA TEMP (DEG C)	08.3	(01 15)	10.4	12.4	(28 18)	247	31
AIR-SEA TEMP (DEG C)	-01.3	(12 15)	00.2	01.4	(28 15)	247	31
PRESSURE (MBAR)	1011.4	(01 03)	1018.3	1028.3	(15 00)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 245

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		.8					.8	9.1
NE								
E		2.8	2.0				4.8	8.6
SE		2.0	8.5	1.6			12.2	14.1
S		4.1	17.9	1.2			23.2	14.7
SW		2.0	5.5	1.2			8.8	14.5
W	1.2	12.2	21.1	6.5			41.1	14.6
NW	.8	2.0	4.9				7.7	12.2
CALM	.4						.4	.0
TOTAL	2.4	26.0	61.0	10.6			100.0	13.8

MAX WIND — SPEED: 32 KNOTS — DIRECTION: 240 DEG — DAY: 01 — HOUR: 00

AUGUST — DATA SUMMARY — EB18

AVERAGE LATITUDE 51.0N — AVERAGE LONGITUDE 136.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	11.7	(23 12)	13.4	15.0	(22 06)	246	31
SEA TEMP (DEG C)	11.6	(01 06)	13.3	14.4	(18 08)	246	31
AIR-SEA TEMP (DEG C)	-02.2	(23 12)	00.1	02.0	(11 00)	246	31
PRESSURE (MBAR)	0981.8	(24 03)	1018.7	1031.2	(02 21)	246	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 246

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	2.4	4.5	14.6	.4			22.0	13.7
NE		2.0	2.0				4.1	9.8
E	1.2	.8	.8				2.8	8.4
SE	.4	1.2	5.3	.8			7.7	14.4
S	1.2	4.1	9.3	2.0			16.7	13.8
SW		5.7	2.4	.4			8.5	10.3
W	.8	9.8	5.7	.4			16.7	10.7
NW		6.9	14.6				21.5	12.6
CALM								
TOTAL	6.1	35.0	54.9	4.1			100.0	12.4

MAX WIND — SPEED: 28 KNOTS — DIRECTION: 100 DEG — DAY: 23 — HOUR: 15

JULY — DATA SUMMARY — EB20

AVERAGE LATITUDE 41.1N — AVERAGE LONGITUDE 137.8W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	13.2	(01 15)	16.1	18.8	(31 21)	248	31
PRESSURE (MBAR)	1014.5	(26 03)	1025.7	1035.0	(14 21)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 248

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		8.1	13.7				21.8	11.8
NE	.4	2.0	3.6				6.0	11.5
E		.8					.8	7.0
SE	1.2	.4					1.6	3.8
S	.4	4.0	6.9				11.3	11.3
SW		3.2	8.5				11.7	13.1
W		6.9	17.7				24.6	12.5
NW		11.3	10.1				21.4	10.7
CALM	.8						.8	.0
TOTAL	2.8	36.7	60.5				100.0	11.5

MAX WIND — SPEED: 18 KNOTS — DIRECTION: 220 DEG — DAY: 28 — HOUR: 18

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 244

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	7.0	87.3	5.7						1.2M	2.5M	(30 06)

AUGUST — DATA SUMMARY — EB20

AVERAGE LATITUDE 41.1N — AVERAGE LONGITUDE 137.8W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	16.3	(08 18)	18.1	22.3	(12 00)	248	31
PRESSURE (MBAR)	1011.8	(24 18)	1021.8	1031.6	(28 21)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 248

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	4.0	21.8				26.2	13.8
NE	.4	3.6	11.3				15.3	12.5
E	.8	1.6	.4				2.8	7.1
SE	1.2	.4					1.6	3.5
S		6.0	8.8				14.8	11.4
SW	.4	2.8	2.8	.8			6.9	11.1
W		2.4	20.2	.4			23.0	14.5
NW	.8	.8	6.5	.4			8.5	13.8
CALM	.8						.8	.0
TOTAL	4.8	21.8	71.8	1.6			100.0	12.8

MAX WIND — SPEED: 25 KNOTS — DIRECTION: 230 DEG — DAY: 24 — HOUR: 18

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	1.2	76.5	21.5	.8					1.5M	3.0M	(24 21)

JULY — DATA SUMMARY — EB34

AVERAGE LATITUDE 40.1N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	18.0	(27 12)	22.2	26.7	(18 18)	240	31
SEA TEMP (DEG C)	18.7	(28 09)	21.8	25.8	(18 18)	240	31
AIR-SEA TEMP (DEG C)	-02.6	(03 18)	00.4	02.1	(20 06)	240	31
PRESSURE (MBAR)	1007.1	(25 21)	1018.3	1027.1	(20 18)	239	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 237

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.3	3.0	6.3	.4			11.0	12.5
NE	.4	3.4	1.3				5.1	9.0
E	1.3	2.1	7.2				10.5	10.3
SE	.8	3.8	2.5				7.2	8.3
S	1.7	5.9	12.2	.8			20.7	12.8
SW	3.8	18.6	14.3	.8			37.6	9.4
W	1.3	2.5					3.8	5.7
NW		2.5	1.7				4.2	9.8
CALM								
TOTAL	10.5	41.8	45.6	2.1			100.0	10.1

MAX WIND — SPEED: 25 KNOTS — DIRECTION: 230 DEG — DAY: 28 — HOUR: 00

AUGUST — DATA SUMMARY — EB34

AVERAGE LATITUDE 40.1N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEJ C)	18.1	(25 15)	22.7	26.1	(09 21)	243	31
SEA TEMP (DEG C)	20.4	(02 09)	22.9	25.1	(10 00)	244	31
AIR-SEA TEMP (DEG C)	-04.8	(21 18)	-00.2	01.8	(07 21)	243	31
PRESSURE (MBAR)	1006.1	(17 21)	1017.3	1027.2	(26 15)	243	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 244

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.2	2.5	3.3				7.0	10.2
NE	1.2	.4	1.6				3.3	7.8
E	1.6	2.0	1.6				5.3	8.8
SE		3.3	2.5				5.7	8.6
S	1.2	14.3	15.5	.4			28.5	10.4
SW	.8	21.7	15.2				37.7	9.7
W	1.6	3.3	.4				5.3	6.3
NW	.4	2.9	2.5				5.7	10.2
CALM	.4						.4	.0
TOTAL	8.6	50.4	40.6	.4			100.0	9.5

MAX WIND — SPEED: 22 KNOTS — DIRECTION: 200 DEG — DAY: 22 — HOUR: 18

JULY — D A T A   S U M M A R Y — E839

AVERAGE LATITUDE 58.2N — AVERAGE LONGITUDE 152.7W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.8	(07 15)	11.2	14.8	(18 06)	219	31
SEA TEMP (DEG C)	08.1	(07 15)	09.8	11.6	(28 21)	219	31
AIR-SEA TEMP (DEG C)	-00.3	(14 18)	01.4	05.8	(02 03)	217	31
PRESSURE (MBAR)	1008.0	(27 06)	1015.1	1027.7	(07 09)	218	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 212

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.9	1.4	.5				2.8	8.0
NE	.5	4.2	.5				5.2	7.1
E	1.4	17.9	15.1	3.3			37.3	11.5
SE	1.4	4.2	.5				6.1	6.8
S	.9	3.8					4.7	6.0
SW	.5	8.1					8.6	6.6
W	.9	9.6	15.6	.5			26.8	11.9
NW	.9	5.2	4.2				10.4	10.0
CALM								
TOTAL	7.5	53.4	38.3	3.8			100.0	10.3

MAX WIND — SPEED: 34 KNOTS — DIRECTION: 100 DEG — DAY: 27 — HOUR: 09

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 209

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	43.1	50.7	6.2						.8M	2.5M	(28 03)

JULY — D A T A   S U M M A R Y — E841

AVERAGE LATITUDE 38.7N — AVERAGE LONGITUDE 073.8W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	18.8	(27 21)	25.3	27.3	(18 21)	240	31
SEA TEMP (DEG C)	21.2	(02 15)	25.4	28.7	(21 21)	242	31
AIR-SEA TEMP (DEG C)	-02.7	(27 21)	-00.1	01.8	(01 15)	240	31
PRESSURE (MBAR)	1007.8	(07 06)	1017.0	1025.3	(28 15)	241	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 241

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.8	3.7	5.0				9.5	10.8
NE	.4	3.7	6.2				10.4	10.5
E	.4	3.3	2.9				6.6	9.3
SE	.4	3.7	.4				4.6	7.8
S	2.5	8.7	8.7	.4			20.3	8.5
SW	.8	15.4	10.4				26.6	9.5
W	1.7	9.1	.8				11.6	6.8
NW	2.1	3.7	4.1				10.0	9.0
CALM	.4						.4	.0
TOTAL	8.5	51.5	38.6	.4			100.0	9.2

MAX WIND — SPEED: 23 KNOTS — DIRECTION: 200 DEG — DAY: 25 — HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 241

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	15.4	78.8	5.0	.8					1.1M	3.0M	(25 21)

JULY — D A T A   S U M M A R Y — E843

AVERAGE LATITUDE 56.8N — AVERAGE LONGITUDE 142.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	05.4	(04 18)	12.5	15.5	(18 03)	216	31
SEA TEMP (DEG C)	10.8	(23 12)	13.4	16.2	(12 03)	220	31
AIR-SEA TEMP (DEG C)	-04.4	(15 21)	-00.9	02.8	(11 00)	215	31
PRESSURE (MBAR)	1005.0	(18 18)	1016.8	1028.6	(07 09)	217	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 218

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.9	.9					1.8	4.3
NE	1.4	1.4	1.8	.9			5.5	11.9
E	1.8	23.7	32.8	.9			59.4	12.8
SE	.5	4.6	1.8				6.8	7.8
S	3.2						3.2	1.8
SW	.9	1.4					2.3	5.8
W	3.7	12.3	1.8				17.8	6.8
NW	.9	1.4					2.3	4.2
CALM	.9						.9	.0
TOTAL	14.2	45.7	38.4	1.8			100.0	9.8

MAX WIND — SPEED: 24 KNOTS — DIRECTION: 070 DEG — DAY: 04 — HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 212

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	24.5	67.9	6.6	.9					1.1M	3.0M	(24 06)

JULY — D A T A   S U M M A R Y — E844

AVERAGE LATITUDE 26.0N — AVERAGE LONGITUDE 088.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	25.3	(16 15)	28.2	30.3	(31 00)	192	25
SEA TEMP (DEG C)	27.3	(23 18)	29.1	32.1	(31 00)	189	25
AIR-SEA TEMP (DEG C)	-03.5	(16 15)	-00.8	01.4	(23 18)	189	25
PRESSURE (MBAR)	1014.0	(28 09)	1017.8	1021.3	(10 18)	193	25

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 193

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.6	1.6					3.1	5.7
NE	1.6	10.9	2.1				14.5	7.6
E	8.7	23.8	3.1	.5			34.2	7.0
SE	3.6	18.1	2.6				24.4	7.0
S	4.7	11.9	1.0				17.6	6.8
SW	.5	2.1					2.6	6.0
W	.5	1.0					1.6	5.3
NW	1.0	1.0					2.1	4.3
CALM								
TOTAL	20.2	70.5	8.8	.5			100.0	6.7

MAX WIND — SPEED: 22 KNOTS — DIRECTION: 080 DEG — DAY: 16 — HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 136

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	86.0	14.0							.5M	1.0M	(26 03)

JULY — D A T A   S U M M A R Y — E863

AVERAGE LATITUDE 40.8N — AVERAGE LONGITUDE 068.5W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	11.3	(10 03)	14.3	18.0	(15 18)	237	31
SEA TEMP (DEG C)	10.1	(08 08)	11.5	14.8	(30 03)	237	31
AIR-SEA TEMP (DEG C)	00.3	(10 09)	02.9	08.4	(26 00)	236	31
PRESSURE (MBAR)	1006.6	(26 06)	1016.9	1027.5	(28 18)	238	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 230

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N								
NE	1.3	2.6	.9				4.8	5.7
E		3.0					3.0	7.3
SE	.4	2.6					3.0	6.6
S	.9	4.8					5.7	5.6
SW	4.8	28.1	15.2				48.1	9.3
W	7.0	18.3	2.2				27.4	5.8
NW	.4	1.3	2.2				3.9	10.0
CALM	3.0						3.0	.0
TOTAL	17.8	61.7	20.4				100.0	7.1

MAX WIND — SPEED: 20 KNOTS — DIRECTION: 220 DEG — DAY: 28 — HOUR: 00

AUGUST — D A T A   S U M M A R Y — E839

AVERAGE LATITUDE 58.2N — AVERAGE LONGITUDE 152.7W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	10.3	(19 15)	11.8	14.4	(28 06)	210	31
SEA TEMP (DEG C)	08.7	(04 18)	11.1	13.8	(30 03)	212	31
AIR-SEA TEMP (DEG C)	-01.4	(24 08)	00.9	03.3	(28 06)	208	31
PRESSURE (MBAR)	0986.5	(08 12)	1015.4	1037.4	(10 21)	215	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 208

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.5	2.8	1.9				5.3	8.8
NE	.9	4.3	5.8				10.6	10.5
E	1.4	8.3	31.7	6.7			48.2	15.3
SE	.5	8.7	8.1	.9			18.0	10.7
S	1.4	2.8					4.3	5.6
SW		3.8					3.8	7.0
W	1.0	2.4	2.4				5.8	8.5
NW	1.4	2.8	1.0				5.3	8.5
CALM								
TOTAL	8.7	34.1	51.9	7.2			100.0	12.0

MAX WIND — SPEED: 28 KNOTS — DIRECTION: 120 DEG — DAY: 17 — HOUR: 18

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 188

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	54.7	32.6	12.8						.8M	2.5M	(13 03)

AUGUST — D A T A   S U M M A R Y — E841

AVERAGE LATITUDE 38.7N — AVERAGE LONGITUDE 073.8W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	18.8	(25 15)	24.1	26.4	(14 08)	244	31
SEA TEMP (DEG C)	22.8	(27 12)	24.4	26.0	(13 21)	244	31
AIR-SEA TEMP (DEG C)	-03.8	(25 15)	-00.4	01.5	(11 03)	244	31
PRESSURE (MBAR)	1008.6	(17 21)	1018.5	1028.7	(28 15)	244	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 244

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.2	3.7	2.5				7.4	8.4
NE	.4	4.8	.4				5.7	8.7
E	.8	4.8	.4				6.1	7.4
SE	.4	1.2	.8				2.5	7.8
S	1.2	22.1	8.6				32.0	8.3
SW	1.6	18.4	14.8	.4			33.2	9.8
W	.4	6.6	.8				7.8	7.5
NW		4.8	.4				5.3	7.7
CALM								
TOTAL	6.1	64.8	28.7	.4			100.0	8.8

MAX WIND — SPEED: 22 KNOTS — DIRECTION: 220 DEG — DAY: 17 — HOUR: 18

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 249

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	.8	93.1	6.1						1.1M	2.5M	(18 00)

AUGUST — D A T A   S U M M A R Y — E843

AVERAGE LATITUDE 56.8N — AVERAGE LONGITUDE 142.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.4	(14 15)	12.8	15.3	(21 03)	215	31
SEA TEMP (DEG C)	08.2	(14 21)	13.6	15.3	(05 03)	216	31
AIR-SEA TEMP (DEG C)	-04.5	(31 12)	-00.8	04.0	(15 00)	215	31
PRESSURE (MBAR)	1000.6	(23 18)	1017.8	1030.8	(02 21)	216	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 212

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.9						.9	1.8
NE	4.2	2.4	.9				7.5	8.1
E	3.8	17.9	21.7	3.3			46.7	12.2
SE	2.8	3.8					6.6	4.8
S	.5						.5	2.0
SW	.9	1.4	.9				3.8	7.0
W	3.8	11.3	13.7				28.8	8.7
NW	1.9	2.8	.9				5.7	6.0
CALM	.5						.5	.0
TOTAL	18.8	38.6	38.2	3.3			100.0	8.7

MAX WIND — SPEED: 28 KNOTS — DIRECTION: 070 DEG — DAY: 08 — HOUR: 18

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 208

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	28.8	58.7	10.6	1.9					1.1M	3.0M	(10 06)

AUGUST — D A T A   S U M M A R Y — E844

AVERAGE LATITUDE 26.0N — AVERAGE LONGITUDE 088.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	23.8	(28 12)	28.1	29.8	(01 21)	242	31
SEA TEMP (DEG C)	26.8	(28 12)	29.0	30.7	(01 21)	241	31
AIR-SEA TEMP (DEG C)	-04.1	(02 12)	-01.0	00.8	(14 03)	241	31
PRESSURE (MBAR)	1011.2	(31 00)	1016.5	1021.2	(18 15)	242	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 242

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.2	1.7					2.9	4.3
NE	.4	2.1					2.5	6.5
E	3.7	16.1	26.0				45.8	10.3
SE	2.5	9.1	8.7				20.2	9.7
S	1.7	7.0	2.1				10.7	7.8
SW	1.7	6.6	.4				8.7	5.6
W	2.9	2.5					5.4	4.5
NW	.4	2.1	.4				2.9	7.3
CALM	.8						.8	.0
TOTAL	15.3	47.1	37.6				100.0	8.0

MAX WIND — SPEED: 28 KNOTS — DIRECTION: 140 DEG — DAY: 28 — HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 160

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	50.9	42.8	6.5						.8M	2.0M	(31 21)

AUGUST — D A T A   S U M M A R Y — E863

AVERAGE LATITUDE 40.8N — AVERAGE LONGITUDE 068.5W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	13.0	(03 03)	16.1	19.0	(14 03)	246	31
SEA TEMP (DEG C)	11.0	(01 03)	13.5	17.1	(27 15)	246	31
AIR-SEA TEMP (DEG C)	-00.5	(28 15)	02.7	08.1	(17 18)	246	31
PRESSURE (MBAR)	1007.0	(18 03)	1018.1	1030.9	(27 12)	246	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 240

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.8	.8	.8				2.5	7.5
NE	.4	1.7	1.3				3.3	7.8
E	.4	2.5					2.9	6.4
SE	2.1	9.2	2.1				13.3	8.5
S	2.5	27.5	6.7				36.7	7.8
SW	4.6	17.1	2.9				24.6	6.8
W	2.5	6.7					9.2	5.4
NW	3.8	3.3					7.1	4.1
CALM	.4						.4	.0
TOTAL	17.5	68.8	13.8				100.0	6.8

MAX WIND — SPEED: 19 KNOTS — DIRECTION: 180 DEG — DAY: 17 — HOUR: 18

JULY D A T A S U M M A R Y E871

AVERAGE LATITUDE 28.0N AVERAGE LONGITUDE 083.9W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	28.0	(18 10)	30.2	32.7	(31 21)	228	31
SEA TEMP (DEG C)	28.2	(09 12)	30.2	32.3	(31 21)	226	31
AIR-SEA TEMP (DEG C)	-03.1	(18 10)	-01.0	01.1	(22 15)	226	31
PRESSURE (MBAR)	1013.5	(27 08)	1017.0	1020.0	(02 10)	227	31

WIND - % FREQUENCIES, MEANS AND EXTREMES NO. OF OBS: 226

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	2.2	1.3					3.5	4.0
NE	.8	3.5	2.7				7.1	9.1
E	.8	20.8	10.8				32.3	9.9
SE	1.8	22.1	12.4				36.3	9.8
S	2.7	9.9	3.1				15.7	7.7
SW	.4	1.3	.4				2.2	7.4
W	.4	1.3					1.8	4.6
NW	.9	1.3					2.2	4.0
CALM	.9						.9	.0
TOTAL	11.1	58.7	30.2				100.0	8.9

MAX WIND
SPEED: 20 KNOTS
DIRECTION: 180 DEG
DAY: 21
HOUR: 08

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 211

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	77.7	22.3							.5M	1.0M	(21 12)

JULY D A T A S U M M A R Y E872

AVERAGE LATITUDE 57.1N AVERAGE LONGITUDE 151.7W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	10.0	(15 12)	12.1	15.7	(18 00)	185	28
SEA TEMP (DEG C)	09.1	(08 10)	11.7	14.7	(19 03)	184	28
AIR-SEA TEMP (DEG C)	-01.6	(28 15)	00.4	03.1	(19 00)	184	28
PRESSURE (MBAR)	1005.7	(27 06)	1014.2	1025.3	(07 09)	185	28

WIND - % FREQUENCIES, MEANS AND EXTREMES NO. OF OBS: 195

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.5	3.6	2.6				6.7	10.0
NE		8.2	5.6	.5			14.4	11.6
E		9.2	17.9	1.0			28.2	13.4
SE	1.5	5.6	8.7	3.1			18.8	13.1
S	2.1	6.2	3.1				11.3	8.0
SW	2.6	5.6	2.0				10.3	8.2
W	2.1	3.6	2.1				7.7	7.1
NW		2.6	.5				3.1	7.8
CALM	1.0						1.0	.0
TOTAL	9.7	44.6	41.0	4.6			100.0	10.8

MAX WIND
SPEED: 28 KNOTS
DIRECTION: 040 DEG
DAY: 31
HOUR: 12

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 189

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	5.5	73.1	20.0	2.4					1.4M	3.0M	(27 18)

AUGUST D A T A S U M M A R Y E871

AVERAGE LATITUDE 28.0N AVERAGE LONGITUDE 083.9W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	25.8	(31 21)	28.8	30.8	(01 00)	227	31
SEA TEMP (DEG C)	28.2	(18 08)	29.7	31.5	(01 21)	227	31
AIR-SEA TEMP (DEG C)	-04.4	(31 21)	-01.2	00.0	(01 15)	227	31
PRESSURE (MBAR)	1003.1	(31 21)	1014.4	1019.3	(18 15)	227	31

WIND - % FREQUENCIES, MEANS AND EXTREMES NO. OF OBS: 227

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.9	1.8	3.5	.9			7.0	13.9
NE	.9	4.0					4.8	5.6
E	1.3	11.9	8.7				22.0	10.0
SE	.9	14.1	16.3	.4			31.7	10.8
S	.4	15.4	8.4				24.2	8.6
SW	.9	2.2					3.1	4.8
W	1.3	1.8	.4				3.5	6.8
NW		.9	1.8				2.6	13.7
CALM								
TOTAL	6.6	52.0	40.1	1.3			100.0	10.0

MAX WIND
SPEED: 33 KNOTS
DIRECTION: 340 DEG
DAY: 31
HOUR: 21

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 223

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	50.2	43.9	4.0	1.3	.4				.6M	4.0M	(31 21)

AUGUST D A T A S U M M A R Y E872

AVERAGE LATITUDE 57.1N AVERAGE LONGITUDE 151.7W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.8	(07 00)	11.8	13.8	(24 03)	228	31
SEA TEMP (DEG C)	10.1	(05 12)	11.5	13.1	(20 00)	228	31
AIR-SEA TEMP (DEG C)	-01.8	(20 15)	00.4	02.4	(17 21)	228	31
PRESSURE (MBAR)	0981.3	(07 15)	1013.4	1025.3	(10 21)	228	31

WIND - % FREQUENCIES, MEANS AND EXTREMES NO. OF OBS: 227

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.9	2.2	2.2				5.3	8.7
NE	.9	4.8	3.5	.4			9.7	9.9
E	.4	8.7	14.1	2.6			26.0	13.7
SE		8.4	12.3				20.7	13.3
S	.9	15.4	6.6				22.9	9.1
SW		4.8	3.5				8.4	8.4
W	.4	1.3	.4				2.2	6.2
NW	.4	2.6					3.1	6.7
CALM	.9						.9	.0
TOTAL	4.8	48.3	42.7	3.1			100.0	10.9

MAX WIND
SPEED: 26 KNOTS
DIRECTION: 080 DEG
DAY: 02
HOUR: 12

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 210

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	5.2	57.6	27.6	9.5					1.6M	3.5M	(12 21)

AUGUST D A T A S U M M A R Y E816

AVERAGE LATITUDE 42.5N AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	16.4	(31 06)	17.4	18.6	(30 03)	21	3
PRESSURE (MBAR)	1016.9	(31 21)	1023.0	1026.8	(30 10)	21	3

WIND - % FREQUENCIES, MEANS AND EXTREMES NO. OF OBS: 21

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		9.5	14.3				23.8	13.0
NE								
E								
SE								
S								
SW	4.8	14.3					19.0	6.3
W		4.8	33.3				38.1	13.0
NW		4.8	4.8	4.8			14.3	14.7
CALM	4.8						4.8	.0
TOTAL	9.5	33.3	52.4	4.8			100.0	11.5

MAX WIND
SPEED: 22 KNOTS
DIRECTION: 300 DEG
DAY: 30
HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 19

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY		47.4	52.6						1.8M	2.5M	(30 12)

Table 6

Selected Gale and Wave Observations, North Atlantic

July and August 1977

Vessel	Nationality	Date	Position of Ship: Lat. deg.	Position of Ship: Long. deg.	Time GMT	Wind: Dir. 10°	Wind: Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C: Air	Temperature °C: Sea	Sea Waves†: Period sec.	Sea Waves†: Height ft.	Swell Waves: Dir. 10°	Swell Waves: Period sec.	Swell Waves: Height ft.
NORTH ATLANTIC OCEAN		JULY															
MARIPOSA	AMERICAN	4	11.6 N	76.6 W	18	09	35	10 NM	02	1010.5	26.7	23.2	6	14.5			
BERGLJOT	NORWEGIAN	7	47.0 N	40.3 W	18	18	M 36	2 NM	10	1022.5	20.0	19.5	8	6.5	19	8	14.5
SOLON TURMAN	AMERICAN	13	36.5 N	10.0 W	06	02	45	5 NM	05	1020.0	17.7	18.9	3	5	33	< 6	11.5
DOCTOR LYKES	AMERICAN	18	49.8 N	02.0 W	06	27	40	2 NM	60	1009.1	15.6	13.9	6	8			
SEALAND PRODUCER	AMERICAN	21	45.5 N	34.8 W	06	23	42	2 NM	63	1005.8	21.1	17.3	10	10	23	12	13
WASHINGTON TRADER	AMERICAN	21	42.1 N	38.5 W	00	21	35	5 NM	15	1014.9	23.0	24.4	4	8			
EXPORT PATRIOT	AMERICAN	21	38.2 N	13.5 W	12	35	35	10 NM	02	1023.0	21.6	19.5	4	8	36	6	11.5
TAGUS	NORWEGIAN	22	41.0 N	53.5 W	17	23	M 40	2 NM	02	1011.5	24.7	23.6	3	11.5			
LIGHTNING	AMERICAN	23	40.4 N	58.9 W	06	19	60	2 NM	81	992.9	26.5	26.0			19	7	29.5
GULF BEAR	AMERICAN	23	42.0 N	53.7 W	12	23	38	2 NM	18	1005.0	24.4	17.8	3	6.5	23	< 6	11.5
AMER LEGEND	AMERICAN	23	43.3 N	55.0 W	18	28	35	10 NM	02	1008.0	15.5	15.0	4	10			
YUKON	AMERICAN	23	36.2 N	63.3 W	00	22	40	5 NM	03	1008.5	25.2	27.8	9	11.5	26	7	6.5
SEALAND PRODUCER	AMERICAN	23	39.0 N	55.0 W	06	24	45	10 NM	02	1011.5	25.5	22.8	6	10			
DOCTOR LYKES	AMERICAN	25	49.0 N	05.4 W	06	27	40	10 NM	81	1005.4	14.4	13.9	12	6.5			
MOBIL AERO	AMERICAN	26	40.6 N	65.3 W	06	22	40	10 NM	03	1009.5	23.8	27.2	5	5	23	< 6	8
EXPORT PATRIOT	AMERICAN	26	40.7 N	64.2 W	12	22	40	10 NM	02	1009.1	26.1	26.7	5	8			
SAM RATULANGIE	INDONESIAN	26	37.0 N	72.0 W	06	25	M 35	5 NM	00	1014.5	26.4	26.0	7	16.5			
STAGHOUND	AMERICAN	28	49.8 N	17.1 W	06	34	35	10 NM	01	1023.4	14.4	16.6	5	6.5			
PRES EISENHOWER	AMERICAN	28	36.9 N	09.5 W	18	34	36	10 NM	00	1015.0	17.2	20.6	4	10			
MAYO LYKES	AMERICAN	30	36.4 N	11.1 W	12	36	36	5 NM	02	1018.6	17.2	18.9	7	10	36	12	10
GREAT LAKES VESSELS																	
PAUL H CARNAHAN	AMERICAN	1	43.8 N	82.5 W	18	24	M 35	10 NM	03		21.0	10.0	4	5			
G M HUMPHREY	AMERICAN	1	46.9 N	85.6 W	18	26	M 36	5 NM	02		5.0	11.0	6	5			
JOHN DYKSTRA	AMERICAN	2	46.8 N	85.3 W	00	29	M 37	10 NM	60		8.0	9.0	4	5			
ARTHUR M ANDERSON	AMERICAN	3	44.6 N	86.7 W	18	16	M 35	10 NM	02		15.0	17.0	5	6.5			
NORTH ATLANTIC OCEAN		AUG.															
METEOR(T-AKR9)	AMERICAN	12	44.0 N	33.2 W	12	28	35	10 NM	02	1010.0	24.4	22.8	5	8	27	9	14.5
SEALAND MARKET	AMERICAN	12	36.0 N	10.4 W	12	35	35	10 NM	01	1015.6	22.5	18.5	6	10			
GUAYAMA	AMERICAN	18	36.6 N	72.5 W	00	22	35	10 NM	03	1014.0	28.3	28.9	5	10			
CARBIDE SEADRIFT	AMERICAN	18	35.8 N	72.1 W	00	20	35	5 NM	02	1015.9	26.7	30.0	6	5	20	6	10
SEALAND MARKET	AMERICAN	24	44.9 N	24.9 W	12	36	35	10 NM	01	1019.0	21.2	20.6	8	13			
AMER ARCHER	AMERICAN	25	47.9 N	17.5 W	18	29	40	2 NM	25	1007.2	14.4	17.3	4	8	29	6	16.5
ADM W M CALLAGHAN	AMERICAN	25	50.8 N	22.2 W	12	30	40	5 NM	02	1011.0	14.4	13.9	4	8	30	8	11.5
ASIA ZEBRA	LIBERIAN	26	53.1 N	13.7 W	06	01	35	5 NM	03	1008.0	14.0	17.0	5	11.5			
AMER ARCHER	AMERICAN	26	47.7 N	19.3 W	00	33	40	5 NM	15	1004.5	15.6	17.3	4	10	32	8	14.5
ADM W M CALLAGHAN	AMERICAN	26	50.6 N	17.8 W	00	35	35	10 NM	01	1011.0	13.6	13.4	4	8	33	8	13
LIGHTNING	AMERICAN	28	46.1 N	28.6 W	06	27	40	5 NM	64	1014.0	18.8	19.8	2	6.5	24	8	14.5
GUADALUPE	AMERICAN	31	28.0 N	91.0 W	15	15	43	5 NM	02	1011.6	28.1	28.3	10	18			
OCEAN STATION VESSELS																	
ATLANTIC H																	
TANEY	AMERICAN	18	38.0 N	71.0 W	03	23	M 40	5 NM	13	1011.6	28.1	27.6	6	11.5			

† Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

Table 7
Selected Gale and Wave Observations, North Pacific
July and August 1977

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C Air	Temperature °C Sea	Sea Waves+ Period sec.	Sea Waves+ Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.	Swell Waves Height ft.
NORTH PACIFIC OCEAN		JULY															
VIOLET	LIBERIAN	2	39.8 N	127.5 W	18	36	M 35	5 NM	02	1022.5	14.0	15.0	5	8			
SANTA MARIA	AMERICAN	5	38.9 N	123.9 W	06	32	40	10 NM	07	1017.3	11.7	11.2					
OGDEN THAMES	LIBERIAN	8	40.8 N	157.5 W	12	12	M 40	.5 NM	25	1010.0	15.0	14.0					
CHEVRON COLORADO	AMERICAN	11	40.1 N	124.4 W	12	33	M 35	5 NM	02	1010.7	12.3		2	6.5	33	7	10
BURTON ISLAND	AMERICAN	11	41.4 N	125.6 W	06	35	M 35	5 NM	07	1018.6	15.0	14.6	5	6.5			
TRANSCHAMPLAIN	AMERICAN	11	37.0 N	124.5 W	00	33	37	10 NM	05	1016.9	15.6	15.6	6	5	33	7	11.5
WALTER RICE	AMERICAN	11	39.6 N	124.5 W	18	33	35	10 NM	01	1012.5	12.3	8.3	5	8	33	8	10
PRES PIERCE	AMERICAN	13	32.4 N	135.5 E	00	24	35	10 NM	01	1016.2	28.9	26.7	4	8			
TAIWAN PHOENIX	SINGAPORE	15	45.7 N	171.6 W	06	20	M 38	30 YD	47	1014.0	13.0	12.0	4	5			
PHILADELPHIA	AMERICAN	16	54.0 N	135.7 W	18	23	40	2 NM	61	999.0	12.2	13.3	7	10	23	9	16.5
CHEVRON COLORADO	AMERICAN	17	39.6 N	126.3 W	12	30	M 35	.5 NM	12	1017.5	12.8		2	5	30	7	8
TOYOTA MARU # 10	JAPANESE	20	36.6 N	150.4 W	12	02	M 36	10 NM	02	1024.0	20.5	22.0	6	11.5			
UNITED SPIRIT	LIBERIAN	22	43.6 N	163.2 E	12	20	M 38	1 NM	05	1008.3	16.0	10.5	7	10			
GALVESTON	AMERICAN	23	56.1 N	146.5 W	06	14	35	2 NM	51	1007.5	11.6	12.1	3	6.5	14	7	10
MILLYER BROWN	AMERICAN	23	57.2 N	138.7 W	18	11	35	5 NM	31	1016.0	12.8	13.9	4	10	11	8	6.5
ATLANTIC PIONEER	PANAMANIAN	24	47.5 N	128.6 W	06	32	M 37	10 NM	01	1021.5	14.0	15.0	4	8			
PRES MCKINLEY	AMERICAN	24	21.0 N	120.7 E	18	16	45	5 NM	65	992.0	23.8	28.8	6	19.5			
PRESIDENT MADISON	AMERICAN	24	49.8 N	160.0 E	23	23	M 35	.25 NM	45	1005.0	11.1	10.0	8	11.5			
PRES MCKINLEY	AMERICAN	25	21.7 N	120.6 E	00	19	70	200 YD	65	999.1	25.6	28.3	5	24.5			
VAN HAWK	LIBERIAN	25	21.3 N	124.4 E	18	17	36	10 NM	03	1006.0	29.0	26.0					
LAUREL	LIBERIAN	26	50.1 N	166.1 W	06	23	M 36	.25 NM	63	1002.0	11.0	10.0	3	8	20	6	11.5
WALTER RICE	AMERICAN	28	17.0 N	143.2 W	12	10	35	10 NM	02	1012.2	25.5	24.0	5	10			
ATLANTIC PIONEER	PANAMANIAN	29	51.2 N	173.0 W	12	29	M 39	2 NM	41	1015.0	9.0	8.0	5	10			
PRESIDENT MADISON	AMERICAN	30	27.9 N	126.6 E	18	09	M 42	10 NM	03	1002.0	28.3	29.4	6	13			
MAINE	AMERICAN	31	27.3 N	122.7 E	00	03	35	5 NM	03	1000.2	28.0	27.3	4	8	10	8	8
NORTH PACIFIC OCEAN		AUG.															
AMER TRADER	AMERICAN	1	27.9 N	145.5 E	18	16	40	5 NM	63	1003.3	27.2	26.7	7	19.5			
MORUP	AMERICAN	1	42.3 N	124.8 W	06	35	40	.5 NM	45	1014.5	12.5	17.2	5	6.5	34	8	14.5
PACIFIC BEAN	AMERICAN	1	23.5 N	124.7 E	00	15	35	5 NM	03	1000.7	27.8	28.3	4	6.5	18	8	14.5
WORLD HERCULES	JAPANESE	1	50.0 N	148.6 W	18	09	M 42	200 YD	47	1008.0	10.0	12.0	7	11.5			
AMER TRADER	AMERICAN	2	26.5 N	145.8 E	00	21	40	5 NM	63	1004.9	27.2	27.6	7	19.5	16	10	19.5
PRES PIERCE	AMERICAN	2	50.4 N	130.9 W	18	32	36	5 NM	12	1025.0	15.7	9.5	3	5			
CHEVRON COLORADO	AMERICAN	2	40.8 N	128.4 W	12	01	M 35	5 NM	03	1018.9	17.0		2	5	01	8	13
CHEVRON COLORADO	AMERICAN	3	42.4 N	131.8 W	00	36	M 35	10 NM	02	1023.9	17.8		2	5	36	8	11.5
CRESSIDA	PANAMANIAN	5	48.4 N	164.4 E	12	21	M 37	.5 NM	41	1009.0	13.5	6.1	10	13	21	10	16.5
MAINE	AMERICAN	6	36.6 N	156.1 E	15	15	48	1 NM	82	997.5	23.0	23.3	8	24.5	10	8	24.5
PRES TAFT	AMERICAN	6	37.2 N	155.9 E	12	10	35	5 NM	02	1000.3	23.9	22.7	7	11.5	20	9	19.5
CRESSIDA	PANAMANIAN	6	47.0 N	161.0 E	00	18	M 38	.25 NM	41	1012.5	16.0	8.3	10	10			
MAINE	AMERICAN	7	36.8 N	157.7 E	00	15	40	2 NM	82	1004.9	23.5	22.3	4	11.5	15	8	14.5
PORTLAND	AMERICAN	7	55.9 N	146.5 W	06	14	40	2 NM	20	997.6	8.9	11.2	6	13			
PRES PIERCE	AMERICAN	7	46.2 N	157.6 E	18	17	35	.25 NM	45	1003.5	15.6	10.6	7	19.5	20	8	19.5
ALEUTIAN DEVELOPER	AMERICAN	7	58.1 N	151.6 W	12	07	35	2 NM	61	997.6	11.1	11.7	4	8	05	8	16.5
ZIM NEW YORK	GERMAN	8	40.0 N	163.2 W	18	29	35	5 NM	81	1013.2	17.8	20.0			29	11	10
CRESSIDA	PANAMANIAN	8	38.7 N	145.0 E	12	16	M 45	.5 NM	59	999.0	22.0	17.1	8	16.5			
EXXON PHILADELPHIA	AMERICAN	9	42.3 N	127.0 W	18	32	M 38	5 NM	02	1018.0	18.0						
MIDAS ARROW	LIBERIAN	9	43.7 N	152.8 E	12	17	M 35	2 NM	19	998.7	20.0	15.0	6	10	17	10	13
PHILADELPHIA	AMERICAN	9	55.8 N	140.4 W	12	11	35	5 NM	31	1018.5	12.2	12.8					
PRES PIERCE	AMERICAN	9	40.3 N	147.3 E	00	18	45	2 NM	02	999.2	22.0	22.0	3	8	18	6	13
CRESSIDA	PANAMANIAN	9	36.7 N	142.8 E	00	23	M 40	2 NM	53	998.0	27.0	19.6	9	16.5			
PRES PIERCE	AMERICAN	10	34.1 N	139.0 E	12	30	35	2 NM	02	1002.0	23.5	23.1	3	6.5			
MICHIGAN	AMERICAN	10	38.0 N	170.9 W	18	32	45	5 NM	61	1014.0	17.8	19.4	5	10			
SEALAND EXCHANGE	AMERICAN	10	44.0 N	170.0 W	06	28	35	2 NM	21	1005.1	14.0	13.4	3	11.5	30	8	14.5
YAMASHIN MARU	JAPANESE	10	44.7 N	167.5 W	06	32	M 38	2 NM	63	999.5	13.5	12.5	4	5	27	7	11.5
MICHIGAN	AMERICAN	11	37.8 N	173.4 W	00	34	45	5 NM	15	1016.3	20.6	18.3	5	6.5	34	7	11.5
GALVESTON	AMERICAN	12	51.1 N	131.5 W	18	34	35	10 NM	03	1021.5	14.5	14.0	3	6.5	34	< 6	10
PHILADELPHIA	AMERICAN	13	53.3 N	134.6 W	18	34	35	10 NM	02	1017.3	12.8	13.9	8	10			
ZIM NEW YORK	GERMAN	14	35.7 N	143.3 E	06	05	42	2 NM	81	1009.5	23.0	27.5	6	16.5	20	7	19.5
AMER LYNX	AMERICAN	14	33.5 N	137.1 E	12	06	40	10 NM	02	1006.0	26.1	26.7					
ALBANY	SWEDISH	14	20.6 N	106.9 W	12	13	35	200 YD	64	1002.5	26.6	27.0	3	5	13	7	6.5
EXPORT BUYER	AMERICAN	15	21.8 N	108.8 W	21	19	60	2 NM	25	1006.4	26.0	26.6	6	19.5	15	>13	24.5
MICHIGAN	AMERICAN	15	30.0 N	141.3 E	18	14	35	5 NM	02	999.5	26.7	26.1	5	8	12	8	19.5
EXPORT BUYER	AMERICAN	16	21.6 N	108.5 W	00	19	35	5 NM	35	1010.3	25.5	27.8	14	24.5			
SHINYO MARU	JAPANESE	17	43.7 N	152.5 W	00	13	M 37	200 YD	63	1010.0	18.5	14.0	7	8	16	8	11.5
AMER LANCER	AMERICAN	19	17.9 N	133.3 E	00	22	35	10 NM	60	1007.1	26.1	28.3	6	8	24	7	11.5
GOLDENROD	LIBERIAN	19	46.5 N	165.6 W	18	12	M 35	1 NM	61	1005.2	16.0	13.0	5	8	12	7	11.5
LONG BEACH	PANAMANIAN	19	36.6 N	144.0 E	00	25	M 35	> 25 NM	03	1007.5	26.0	28.0	8	6.5			
HOLLAND MARU	JAPANESE	20	44.2 N	167.2 W	00	29	M 39	5 NM	02	997.3	14.5	13.5	5	10	30	9	11.5
GOLDEN MARINER	PANAMANIAN	20	49.8 N	153.7 W	15	13	M 35	1 NM	05	1009.0	14.0	12.5	6	8			
ELISABETH BOLTEN	GERMAN	20	46.7 N	166.5 W	18	27	40	2 NM	50	994.0	12.5	12.0	6	10	27	>13	11.5
VAN CONQUEROR	LIBERIAN	20	52.6 N	160.8 W	12	11	M 42	2 NM	50	1000.0	12.0	13.0					
PRES TAFT	AMERICAN	20	25.1 N	121.0 E	00	01	40	5 NM	02	998.8	27.7	26.2	6	10	01	7	19.5
ALEUTIAN DEVELOPER	AMERICAN	21	59.3 N	149.2 W	18	07	35	10 NM	02	1010.4	14.5	13.1	4	10			
PRES KENNEDY	AMERICAN	21	18.0 N	120.3 E	00	22	35	2 NM	63	999.3	25.0	27.2	5	10	22	10	11.5
PASSUMPSIC	AMERICAN	21	21.4 N	123.9 E	18	18	M 28	10 NM	02	999.5	29.4	28.3	3	8	20	7	24.5
PLUVIUS	GERMAN	21	41.3 N	153.8 E	06	05	37	2 NM	50	999.3	19.8	20.4	8	13	09	10	13
VAN CONQUEROR	LIBERIAN	21	52.6 N	165.4 W	00	10	M 35	5 NM	50	987.0	13.0	13.0					
MICHIGAN	AMERICAN	21	18.9 N	120.5 E	06	21	35	1 NM	82	998.0	26.7	27.8	7	10	21	8	32.5
PRES PIERCE	AMERICAN	21	42.2 N	155.9 E	12	08	59	5 NM	50	1003.0	20.0	19.5	3	10	08	8	16.5
ARNULO MAERSK	DANISH	22	35.1 N	143.0 E	18	09	40	5 NM	25	1002.0	24.5			8			
OCEANOGRAPHER	AMERICAN	22	49.6 N	144.9 W	18	24	M 41	2 NM	63	996.3	12.0	12.5	6	8	20	< 6	5
SVENDBORG MAERSK	DANISH	22	30.0 N	139.2 E	06	21	37	2 NM	02	992.5	28.5	28.0	10	19.5	22	12	32.5
AMERICA MARU	JAPANESE	23	39.1 N	176.9 W	06	21	M 35	.25 NM	81	1004.5	22.0	20.0	7	10	25	8	13
OCEANOGRAPHER	AMERICAN	23	49.7 N	145.1 W	12	29	M 36	5 NM	63	995.8	12.5	12.0	6	13	24	6	6.5
ARNULO MAERSK	DANISH	23	35.7 N	145.7 E	00	08	40	2 NM	65	1003.5	23.8	25.5	10	8	06	13	16.5
MONTANA	AMERICAN	23	36.2 N	178.8 W	18	23	40	10 NM	03	1009.1	23.3	22.8	4	6.5	29	9	11.5
VAN WARRIOR	LIBERIAN	23	49.9 N	138.1 W	12	23	40	5 NM	03	994.5	15.0	12.0					
AMER LANCER	AMERICAN	24	29.9 N	130.3 E	06	29	50	5 NM	01	995.6	27.3	27.1	5	10	29	>13	14.5
VAN WARRIOR	LIBERIAN	24	50.6 N	141.6 W	00	32	35	10 NM	03	994.0	16.0	13.0					
PRES FILLMORE	AMERICAN	24	32.2 N	133.5 E	12	19	35	5 NM	25	993.9	23.5	27.8	4	10	11	< 6	13
GALVESTON	AMERICAN	24	49.7 N	127.4 W	18	16	35	10 NM	03	1002.0	14.5	13.5	5	5			
ROSE	LIBERIAN	24	34.4 N	134.1 E	22	07	M 45	1 NM	25	999.5	21.5	27.5		32.5			
ROSE	LIBERIAN	25	32.7 N	132.2 E	12	04	M 40	2 NM	03	994.0	24.8	28.0		19.5			
PRES JEFFERSON	AMERICAN	25	34.4 N	138.9 E	00	04	45	5 NM	02	1001.8	22.2	26.1	6	11.5			
PRES TAFT	AMERICAN	25	38.3 N	147.0 E	12	07	35	10 NM	01	1005.8	24.3	20.6	8	8	08	11	14.5
MONTANA	AMERICAN	26	27.0 N	160.0 E	06	20	43	10 NM	03	1004.8	28.3	27.7	4	8	23	9	16.5
AVILA	AMERICAN	29	37.4 N	123.7 W	18	33	35	2 NM	05	1017.2	19.4	16.1	4	6.5	33	6	11.5

+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or > 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

Rough Log, North Atlantic Weather

October and November 1977

ROUGH LOG, OCTOBER 1977--This was an average month for storms across the North Atlantic shipping lanes. The primary path that affected ships stretched from the east coast of the United States to Iceland and into the Greenland Sea. The usual number of LOWs moved across southern Canada. There was an anomalous high number of Lows over northeastern Canada that moved northward over and along Baffin Bay.

The outline of the mean pressure pattern was near normal. The Icelandic Low at 995 mb was 10° longitude farther east than normal at 60°N, 20°W, and 6 mb lower in pressure. There was an anomalous 1006-mb LOW over Cape Dyer. The Azores High at 1023 mb near 33°N, 39°W, was 4 mb higher than the climatic normal and about 9° longitude west of its normal position. There was also an anomalous trough from the vicinity of Belle Isle to Cape Cod. The pressures over the United States were near normal. Over Ireland the pressures were below normal, with above normal over central Europe and the Mediterranean Sea.

The primary anomaly center was a negative 9 mb near 57°N, 20°W, associated with the deeper Icelandic Low. There were positive anomaly centers over the central ocean and the Mediterranean Sea.

Normally, the upper air at 700 mb rotates around two LOWs over the Arctic Ocean. This month, one of these was displaced farther south than normal near 77°N, 90°W. An anomalous LOW was southwest of Iceland near 63°N, 27°W. These two centers produced deeper and sharper troughs along the east coast of the United States and west of Europe. The height of the HIGH over the central Atlantic was greater than normal, and the center was about 5° latitude to the north of its normal position. This bulge produced a ridging effect north of the center, tightening the gradient considerably, with stronger winds.

Hurricane Evelyn and tropical storm Frieda occurred during the last half of the month.

Extratropical Cyclones--This storm was over Newfoundland on the 1st. By 1800 on the 2d, the 994-mb storm was near 59°N, 30°W. A U. S. S. R. ship near 54°N, 40°W, reported 50-kn winds and 13-ft seas. At 0000 on the 3d, another ship from the Soviet Union near 55°N, 38°W, had 45-kn gales. At 1200 on the 4th, the storm was 980 mb. The OSTROV KOTLINE (57°N, 31°W) was sailing into 33-ft seas. On the 5th the buoy near 62°N, 30°W, measured 45-kn gales (fig. 53). At midday on the 6th, the storm was centered over Wales bringing heavy rains to England. Ocean Weather Station Romeo had 40-kn winds driving 23-ft seas. The seas were 25 ft 12 hr later.

On the 7th the LOW stalled near the Brest Peninsula. The TROLL PARK fought 45-kn winds and 26-ft seas west of the center. At 1200 on the 8th, another LOW moved southeastward and combined with this center. The PENHIR was near 52°N, 20°W, with howling 60-kn winds. To the south Romeo now had 21-ft seas. The 10,000-ton Finnish containership SOLANO arrived

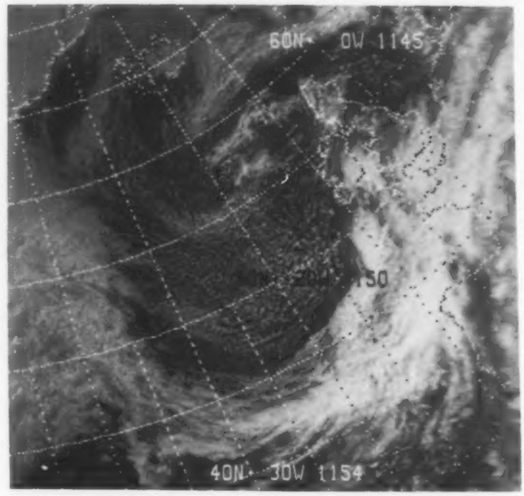


Figure 53.--The storm on the 5th is getting ready to invade the British Isles.

Maderia at 1700 on the 8th. She had lost seven containers which were stowed atop No. 1 hold portside overboard about 250 mi southwest of Lisbon in heavy weather. Cargo was also damaged inside the holds, and 8 m of portside rail was damaged. On the 9th Romeo had 23-ft seas as the LOW dissipated, and another LOW over Scotland took over the circulation. This was probably the storm which damaged the 4,429-ton Greek cargo vessel PANAGIA on a voyage from Havana. The damage was reported at Balboa.

Late on the 8th, a LOW formed in the col area between two HIGHs. It moved northeastward, and at 1200 on the 10th it was 985 mb near 50°N, 25°W. The VOL-JANINE (48°N, 28°W) was pounded by 60-kn winds. Other ships in the area were contending with 50-kn winds and high seas. The TROLL PARK (44°N, 32°W) was hammered by 30-ft seas and 33-ft swells, while the C. P. DISCOVERER (51°N, 32°W) had 28-ft swells.

A ship near OWS Romeo was tossed by 25-ft seas on the 11th. The DISCOVERER now had 36-ft swells near 50°N, 25°W. At 1200 the central pressure of the LOW was 967 mb (fig. 54). The GENE TREFETHEN (51°N, 24°W) was whipped by 52-kn winds, 20-ft seas, and 30-ft swells. Fishing vessels south of Iceland were tossed by 40- to 50-kn winds. On the 12th the ALBRIGHT EXPLORER also had 52-kn winds and 30-ft waves near 56°N, 13°W. The LOW dissipated on the 14th over the Norwegian Sea.

This East Coast storm formed as a frontal wave over

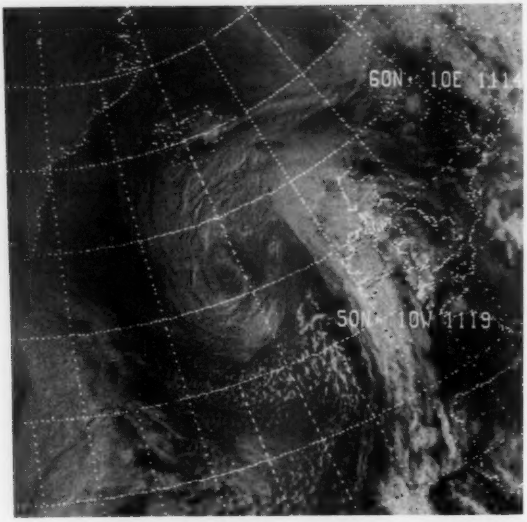


Figure 54.--The storm is wound-up as it pounds shipping in the western approaches to Europe.

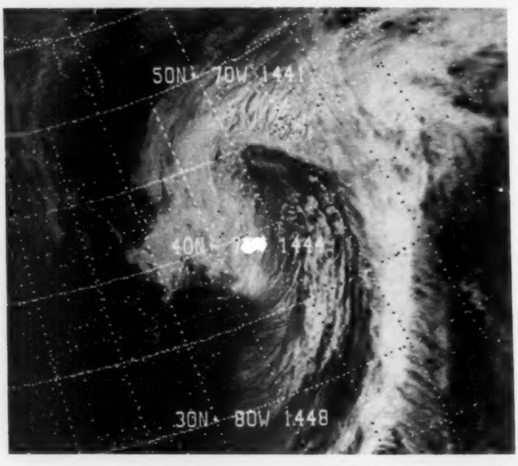


Figure 55. --This LOW pounded the coastline from Cape Hatteras to New England.

the Gulf Stream off Florida on the 13th. At 1200 the EXXON CHESTER was off Cape Hatteras with 50-kn northerly winds. On the 14th the AMERICAN CORSAIR was south of Nantucket Island with 50-kn winds. The 998-mb LOW was just off Cape Hatteras at 1200, producing high tides from the Carolinas to New Jersey. Gale warnings covered the New England coast, and Boston had winds of 45 mi/h. Tides were running 2 ft above normal along the coast of New Jersey, and water levels of 6 in to 1 ft were over coastal roads in Delaware and southern New Jersey. Heavy rains added to the damage (fig. 55).

The storm continued to move up the Atlantic coast.

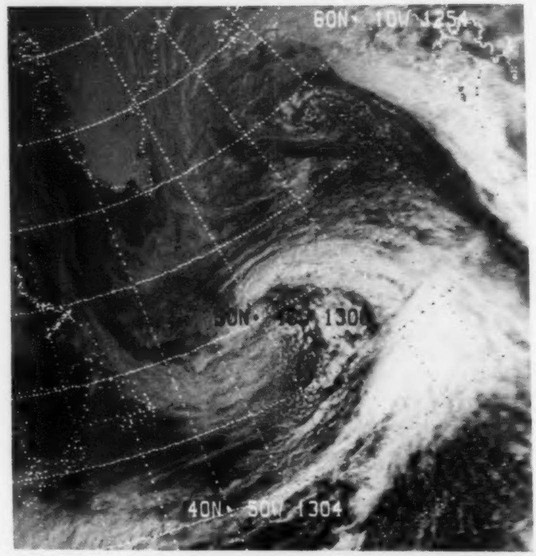


Figure 56. --Located near 50°N, 40°W, on the 14th, hurricane-force winds were being reported from this rapidly deepening storm.

The EXXON BOSTON was near 39°N, 74°W, at 1200 on the 15th with 50-kn winds and 12-ft waves. Hurricane Evelyn had formed east of the storm in the warm sector at 0000, and they were moving in parallel tracks. By the 16th Evelyn had disappeared. The VAN HAWK south of Argentia had 52-kn winds. On the 18th, the storm dissipated south of Kap Farvel.

A LOW exploded over Labrador on the 13th on a front extending from a LOW that was traveling from the Great Lakes to Davis Strait. A ship north of Trinity Bay fought 50-kn winds and 21-ft seas early on the 14th. At 1200 the LOW was 980 mb and almost directly over OWS Charlie (fig.56). The FEDSTEEL (42°N, 28°W) was engulfed by 72-kn winds at 1800. Not far away, the DART AMERICA rocked with 23-ft swells. At 1200 on the 15th, the pressure had dropped to 972 mb near 48°N, 24°W. The DART AMERICA (45°N, 36°W) was sailing westward with 50-kn starboard winds and waves of 23 ft. A ship 400 mi south of the center also suffered 50-kn winds. OWS Romeo measured 45-kn winds and 26-ft seas east of the center. The C. V. LIGHTNING near 50°N, 29°W, was sailing into 50-kn northwesterly winds and 20-ft seas on the 16th. Other ships around the storm were fighting waves up to 30 ft. High winds and waves continued through the 17th, and the storm deteriorated into a trough on the 18th.

This was one of a series of LOWs that moved along the U. S. East Coast. It formed over Virginia and North Carolina on the 16th. The cold front swung rapidly eastward. A ship off Cape Hatteras reported 34-ft seas behind the front (fig. 57). The CHEVRON MADRID was slightly farther north at 1200 on the 17th

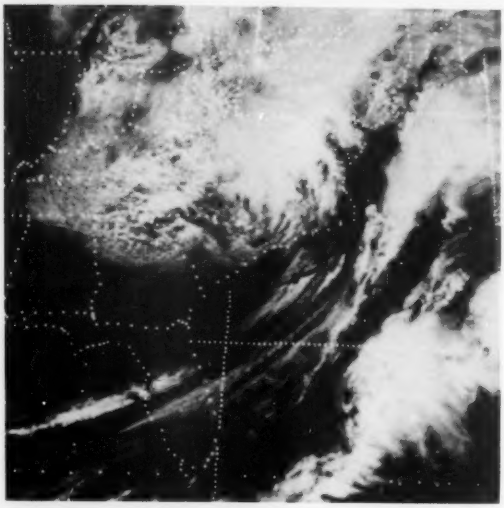


Figure 57.--This LOW is getting it together on the 16th near Cape Hatteras.

(38°N, 70°W), where she found 45-kn winds and 33-ft seas. An American ship 3° longitude to the east was fighting 70-kn winds. The LOW was 986 mb near Boston. The storm continued northeastward hugging the coast and weakening. On the 19th a ship north of Notre Dame Bay was hit by 50-kn northeasterlies.

On the 20th the storm was caught in the zonal flow and intensified as it raced across the water. At 1800 the MOHAMEDIA (48°N, 28°W) was tossed by 50-kn winds and 26-ft swells. The storm was 980 mb near 55°N, 19°W, at 1200 on the 21st. The CIROLANA found 40-kn winds and 30-ft swells about 300 mi west of the center. On the 22d the storm died rapidly as another center formed near Iceland.

This was another one of the series of LOWs that moved along the U. S. East Coast. This one moved over the Appalachian Mountains late on the 19th. As the center moved over Newfoundland on the 22d, its pressure fell to 986 mb. A ship 700 mi south of the center found 40-kn gales and 20-ft seas. As the storm moved eastward, it continued to deepen. There were few reports, but a ship near 49°N, 34°W, radioed 50-kn winds. The storm was 974 mb near 57°N, 29°W, at midday on the 23d. The PACIFIC SKOU near 51°N, 32°W, was hit by 80-kn winds. The AMERICAN LEGEND farther south near 45°N, 31°W, faced 39-ft swells. Another ship sailing northeastward along the front was buffeted by 64-kn southwesterly winds.

The LOW turned more northerly in its track on the 24th. It treated OWS Lima to 56-kn winds and 16-ft seas at 0600 as it passed north of her position. Late in the day the center moved over the east coast of Iceland and into the Norwegian Sea.

Lake Winnipeg spawned this storm on the 19th. It remained a weak frontal wave until it approached the Gulf of St. Lawrence on the 23d. By 1200 it was 992 mb near Corner Brook and strengthening. A Soviet ship north of Notre Dame Bay was buffeted by 62-kn bone-chilling northerly winds on the 24th. At 1200 the CIROLANA was sailing southwestward along the cold front with 30-ft swells near 51°N, 31°W. On the 25th the LOW moved over the northwestern peninsula of Iceland and was absorbed by another cyclone north of the Denmark Strait.

A deep LOW crept across Hudson Bay, and this cyclone formed over Labrador on the 27th. There was a long easterly fetch between Newfoundland and Scotland south of this center, and another LOW east of Iceland. There were reports of waves of 15 to 20 ft from coast to coast. At 0600 on the 24th, the VANCOUVER TRADER was plunging into 30-ft swells northeast of Trinity Bay. In the next 6 hr the storm deepened rapidly to 972 mb. The cyclone was near 57°N, 35°W, and the ATLANTICA MILANO (49°N, 44°W) was pounding into 50-kn winds and 21-ft seas. Other ships were contending with 40- to 50-kn winds, with the highest waves reported at 30 ft.

On the 29th a frontal wave was racing eastward between latitudes 45° and 50°N. As the small center moved, it rapidly shifted the winds and alternately relaxed and tightened the pressure gradient. The highest wind was about 50 kn, but the seas were running 20 to 25 ft over a large area (fig. 58). On the 30th the 962-mb LOW was south of Iceland as it absorbed the frontal wave. A large group of vessels in and north of the North Sea reported 40- to 50-kn winds. The seas varied from 15 to 30 ft. Stations along the Norwegian coast were measuring 40-kn prevailing winds. On the 31st the North Sea fleet had little respite. In November the storm continued northward over the Greenland Sea.

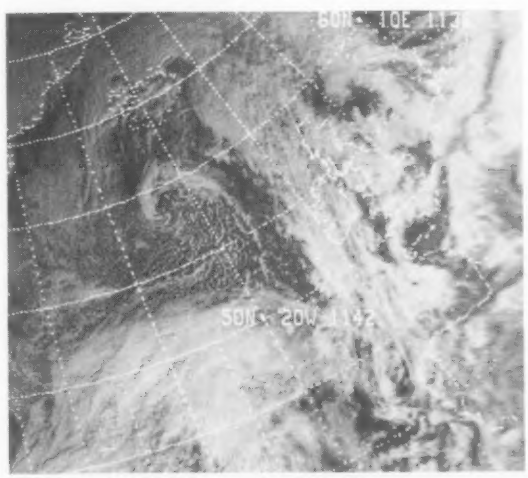


Figure 58.--Cloudy area between 45° and 50°N is region of cyclogenesis.

This was almost a November storm. The front associated with the previous storm dropped to approximately 35°N between the Azores and Madeira, which it then paralleled westward. At midday on the 31st, a frontal wave was analyzed between longitudes 40° and 45°W. The reports from three ships were especially significant in identifying this wave. It rapidly pulled

cold air southward and intensified. The Greek cargo vessel TINA (1,364 tons) sank near Brest on the 31st after encountering 50-kn winds and 20-ft seas. Ten crewmembers were drowned, five were rescued by the Moroccan SELMA, and six were missing. The pressure was 988 mb by 0000 on November 1. At that time it was centered near 46°N, 35°W. The VASILIY KACHALOV was about 120 mi to the southeast, where she had 45-kn winds and 26-ft seas pounding her portside. At 1200 the English ship ARCTIC TROLL near 45°N, 23°W, found 50-kn storm winds and 21-ft waves. The 227-ton Panamanian supply vessel AMERICAN MOON put into South Hampton due to heavy weather damage. On the 2d the storm moved over the Irish Sea. The North Sea fleet again caught the brunt of winds up to 50 kn and seas over 20 ft. The 3,312-ton Uruguayan cargo vessel ESTEMAR II suffered heavy weather damage on the 3d. She was enroute Rotterdam to St. John, but was diverted to Vigo for repairs. As the storm crossed the North Sea, it faded.

Tropical Cyclones--Hurricane Evelyn began as a tropical wave which crossed the African coast on the 3d. The main impulse associated with the wave moved westward at the rather low latitude of about 6°. The Bermuda-Azores High was weaker than normal over the western half of the North Atlantic, which allowed the disturbance to turn northwestward toward the sub-Tropics. During the 9th through 12th, the sprawling, disorganized cloud pattern associated with the disturbance gradually consolidated. On the 13th the upper atmospheric circulation pattern became favorable for development, and satellite pictures indicated that a surface depression had formed about 400 mi south of Bermuda.

As the depression headed toward Bermuda, ships in the zone of strong pressure gradient to the east of the circulation center encountered gale-force winds early on the 14th. The "best track" indicates that Evelyn became a tropical storm at this time. At 0920 on the 14th the Naval Air Station on Bermuda recorded a minimum pressure of 1003.8 mb and a shift of surface winds from east to west. At 1000 the station's radar located the center at a bearing and range of 50° at 10 mi. Strong winds were confined to the eastern semicircle over the open water. The strongest surface winds measured at Bermuda were only 15 kn with gusts to 26 kn.

After the center passed over Bermuda, Evelyn accelerated north-northeastward and strengthened as she attained a forward speed of 30 kn (fig. 59). At 0000 on the 15th, Air Force reconnaissance measured a central pressure of 994 mb and low-level winds of 72 kn. Meanwhile, an intense extratropical storm just off the U.S. East Coast was paralleling hurricane Evelyn's track. Gale and storm warnings were posted along portions of the New England coast swept by this storm. As Evelyn raced toward the Canadian Maritime Provinces, it was apparent that she would encounter the frontal zone associated with the East Coast storm, and it was questionable how long the hurricane could maintain tropical characteristics. Air Force reconnaissance indicated that the storm had an extratropical appearance as the center moved onshore over Cape Breton Island, Nova Scotia, during the morning of the 15th. Satellite pictures showed that the hurricane's cloud mass was merging with that of the front. However, the RANGER encountered 68-kn easterly winds and a pressure of 1001 mb just off the southwestern tip of Newfoundland at 1800. Therefore, Evelyn was still a hurricane up to this point on the "best track."

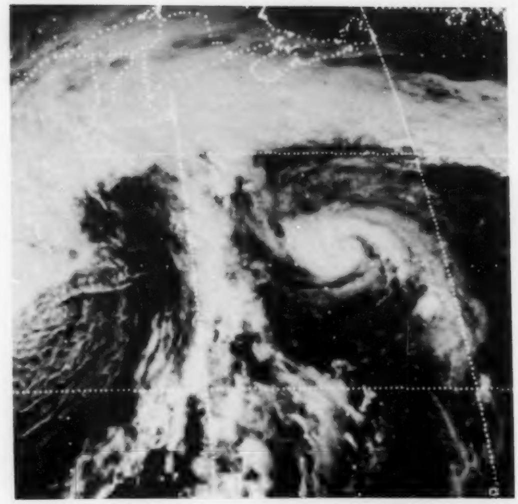


Figure 59.--Evelyn is approximately 150 mi north of Bermuda at 1700 on the 14th. The front is along 70°W.

The storm weakened rapidly as it moved inland over extreme western Newfoundland and merged with the front. Gusts of gale force were reported from Stephenville and St. John's, probably due to the combined effects of the remnants of Evelyn and the front.

No reports of damage or casulaties have been received. Evelyn's lowest pressure was 994 mb at 2305 on the 14th, and her highest sustained surface winds were 68 kn on the 15th.

Frieda was a short-lived tropical storm in the northwestern Caribbean. She originated as a tropical wave off the African coast on the 4th. It traveled westward for the next 10 days without incident; then, a large convective cloud mass associated with this wave moved from the central Caribbean on the 14th to the northwestern Caribbean on the 15th and 16th.

Late on the 16th, reconnaissance aircraft located a surface circulation center just east of Swan Island, which was identified as a tropical depression. The center remained very well defined until midday on the 18th. It moved steadily and slowly westward and crossed the coast of Belize in Central America just north of Belize City late on the 18th. For most of Frieda's duration, the associated circulation pattern was confined to the lower troposphere as evidenced by the lack of middle and upper cloudiness near the center. Therefore, the storm's motion was controlled by the easterly trades, which resulted in a steady westward course.

On the 17th reconnaissance aircraft reported a band of strong westerly winds between the center and

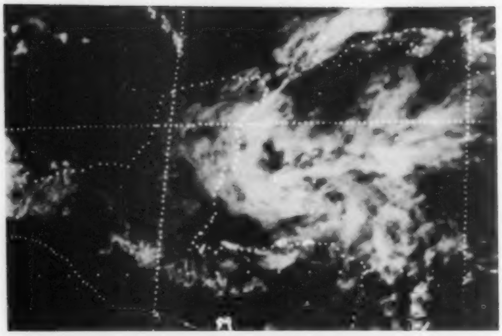


Figure 60.--Frieda, off the Yucatan Peninsula, never got very well organized.

the northern coast of Honduras. Frieda was upgraded to a tropical storm with 50-kn winds about 50 mi south of the center. Satellite pictures indicated a very well-defined, low-level center (fig. 60). There was considerable rainfall associated with this system. Swan Island reported 4.46 in during the 30-hr period ending at 1200 on the 17th, and Grand Cayman had 5.42 in during the 36-hr period ending at 1800 on the 16th.

By landfall late on the 18th maximum winds had decreased to well below gale force. Belize City, just south of the point of landfall, had only light rain and light westerly winds. There are no reports of damage or casualties.

Casualties--All casualties have been reported in the narratives above.

ROUGH LOG, NOVEMBER 1977--This was a maverick month as far as the cyclone tracks and mean pressure pattern matching climatology. Normally, there is a track across the Great Lakes into the Labrador Sea and another from off the east coast of the United States to Iceland and beyond. This month the tracks were very scattered and diffuse. Storms from the northern plains moved toward Hudson Bay and Baffin Bay. Those that formed or traveled along the East Coast moved northeastward toward the Labrador Sea, except for one. A series of scattered cyclones formed over the central ocean and traveled in varied directions from northward to eastward.

There were few exceptions to the above. A storm from the northern plains of the United States crossed the Greenland Ice Cap near 68°N and then turned southeastward into northern Europe. A storm from the Pacific crossed southern Canada and the Atlantic before dissipating south of Iceland.

The primary center of the Icelandic Low was 994 mb and off the Norwegian coast near 69°N, 10°E. A secondary 1002-mb center was on the western coast of Greenland near 67°N, 55°W. The Bermuda-Azores High was split into two centers by a deep trough along 31°W. A 1022-mb center was just north of Madeira Island, and a 1024-mb center was near 38°N, 56°W.

The largest anomaly center was minus 14 mb near Stockholm in conjunction with the primary LOW. A minus 8-mb center was over central Greenland, and the trough in midocean produced a minus 4-mb anomaly near 40°N, 30°W. There were positive anomaly centers on both sides of this last negative center, which reflected the high-pressure cells.

The upper air flow between the two coasts was mainly zonal with the surface trough over midocean well reflected at 700 mb.

November 30 marked the official end of the 1977 hurricane season. There were six named cyclones: Anita, Babe, Clara, Dorothy, Evelyn, and Frieda. All but Frieda reached hurricane force. Although the season is over, storms have been observed in the Atlantic area during every month of the year except April.

Extratropical Cyclones--The first severe marine weather this month was associated with a high-pressure center, rather than a LOW as is the usual case. Actually, any strong winds have to be associated with both as a gradient is required and the terms are relative. This HIGH moved eastward from the northern plains of the United States to the province of Ontario and then southward across New England, where it again turned eastward. On the 1st the 1035-mb center was off Cape Cod near 42°N, 67°W. The coast south of Long Island was subjected to constant easterly winds blowing over a long fetch and creating higher than normal waves and surf. An Indian ship, the VISHVA ADITYA (fig. 61), out of Baltimore returned to Norfolk on the 2d with a 15° list after her cargo shifted. There was serious beach erosion along the exposed coastline (fig. 62).

Figure 61.--The VISHVA ADITYA lists at about 15° after returning to Norfolk when her cargo shifted. Wide World Photo.

Figure 62.--A bulldozer at Ocean City, Md., moves sand and tries to save some of the valuable sand of the beach from being washed away. Wide World Photo.

Figure 63.--Waves pound a grounded 298-ft barge north of Hatteras. Wide World Photo.

Ships off the coast were generally reporting 20- to 35-kn winds with the waves 8 to 12 ft. The High moved slowly eastward with little change in intensity. On the 5th a cold front crossed the coast with another HIGH centered over Ontario right behind. On the night of the 4th a barge carrying 2 million gal of liquid asphalt broke away from its tug and grounded 11 mi north of Hatteras on the outer banks (fig. 63).

This second HIGH continued the easterly winds along the southeastern coast. The air off the ocean was laden with moisture, and heavy rains east of the Appalachian Mountains brought flash floods to the area. On the 6th an earthen dam in Georgia failed, and 33 persons lost their lives. As the HIGH moved off Maine, it dissipated; but another was following in its tracks.

A LOW that had been stationary over the Gulf coast started moving northward on the 6th. A tropical depression that had formed south of Bermuda was moving northwestward toward Cape Hatteras on the 6th and 7th. The more intense gradient and higher winds were north of Norfolk. Wind gusts of over 50 kn were measured along the New Jersey coast. The HIGH moved over Nova Scotia and to sea on the 8th.

This storm came off the Pacific and retained its identity as it raced across the continent. It crossed the coast of British Columbia at 1800 on the 1st and crossed the Labrador coast at 1500 on the 4th. The 976-mb center passed south of Kap Farvel on the 5th. At 0000 on the 6th, OWS Charlie measured 40-kn gales and 20-ft waves. The C.P. TRADER was at 53°N, 30°W, 12 hr later, with the same 40-kn gales, but the waves had increased to 23 ft. At 0000 on the 7th, she was headed into 30-ft swells from the west. The ERNST KRENKEL was farther southwest of the LOW near 50.5°N, 35°W, with 25-ft seas. The 1200 chart with more observations indicated waves up to 15 ft as far as 1200 mi south of the center. Charlie now had 26-ft seas, and the FCCV was caught by 50-kn winds in the vicinity of 43°N, 39°W, ahead of a minor trough. The LOW was southeast of Iceland on the 9th when it disappeared.

The trough referred to in the narrative above developed a closed LOW on the 0000 chart of the 8th. In 12 hr the pressure plunged to 978 mb near 41°N, 38°W. The OPALIA at 38°N, 45°W, was caught by 50-kn winds and 20-ft seas. The ALLISON LYKES passed the front heading westward and found 36-ft swells (fig. 64). On the 9th at 1200 the 965-mb center was near 48°N, 30°W. The TEMPLE INN (41°N, 43°W) contended with 55-kn winds and 38-ft seas. Another ship 400 mi south of the center had 50 kn and 33 ft. OWS Romeo monitored 26-ft seas at 0000 on the 9th. High seas continued through the 10th and 11th with the winds 40 to 50 kn. On the 12th the primary center shifted to what had been a secondary LOW. This LOW moved eastward across Scandinavia into the U.S.S.R.

Another exception to the general run of storms. This was the one that crossed the Greenland Ice Cap. It had its origin over the Midwest on the 9th and rapidly consolidated the circulation as it moved northward prior to turning toward the Great Lakes. The 994-mb center was over Lake Superior at 1200 on the 10th

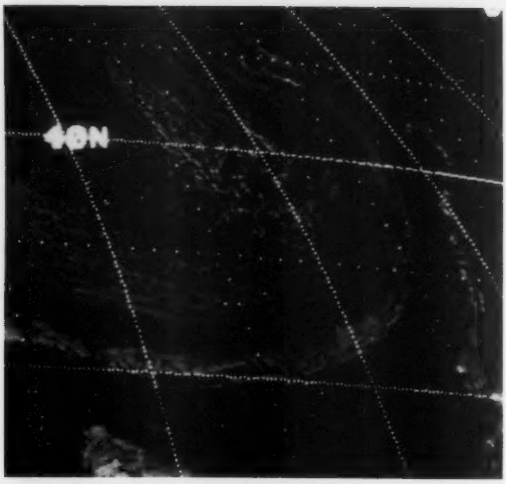


Figure 64.--The storm can be plainly seen even though it is near the horizon on this GOES satellite image.

when gale warnings were posted for both Lakes Superior and Michigan. At 1200 on the 12th the 976-mb center was over Cape Chidley. A station on the west side of Ungava Bay reported bone-chilling, 40-kn northwesterly winds. Later in the day a ship north of Hamilton Inlet braved 58-kn winds and 20-ft seas. On the 13th a Danish ship off Holsteinsborg (67°N) found 52-kn northerly winds at -4°C. By 1200 the storm had survived crossing the Ice Cap and was 970 mb over Denmark Strait. OWS Lima measured 40- to 50-kn winds for the next 24 hr with seas over 25 ft building to 38 ft by 1200 on the 14th. At 0000 on the 14th Angmagssalik measured 80-kn downslope winds from off the Cap. At 1200 the LOW was 958 mb north of the Shetland Islands. Several ships had seas or swells over 30 ft, and the fleet on both sides of Scotland suffered 45- to 60-kn winds.

The LOW was traveling southeastward and passed south of Oslo on the 15th. The SOULOI was west of Ireland, far from the center (54°N, 17°W) with roaring 75-kn winds and 24-ft seas. Lima had 33-ft seas. By the 16th the high winds and seas calmed as the LOW moved into Finland.

A front out of a LOW over Davis Strait lay north-south along 45°N on the 20th, and a wave developed near 44°N, 46°W. At 1200 on the 21st it was 990 mb near 50°N, 49°W, a small tightly wound storm that was moving northward between two 1032-mb HIGHs. The WESER EXPRESS was about 100 mi southeast of the center with 40-kn gales and 16-ft waves. At 1800 a SHIP off St. John's battled 55-kn northwesterly winds. On the 22d the LOW dissipated as fast as it had developed.

This LOW formed in the same small col area as the previous one, only farther south, at midday on the 21st. On the 22d it was 990 mb near 40°N, 47°W. The HAHENTOR was southwest of the LOW with 46-kn gales and 26-ft swells. As the last storm died, this one absorbed part of its circulation. Winds of 35 to 40 kn were found both north and south of the center with seas to 20 ft on the 23d. There were also two reports of 50 kn winds. A second center had formed 300 mi to the south. On the 24th the ACHILLES at 36°N, 44°W, was struck on the heels with 26-ft seas. The LOW had now split into two separate centers. On the 24th the storm reached 55°N and turned sharply eastward. The ANNA JOHANNE (58°N, 45°W) had 53-kn northeasterly winds and 26-ft seas. Twelve hours later the winds were 60 kn and the seas 30 ft. Ships south of the LOW had 35 to 45 kn and 20- to 25-ft seas. The AMERICAN ARCHER (47°N, 42°W) was slammed by 50-kn winds and 33-ft seas and swells. The northern LOW continued northward and grounded north of Kap Farvel on the 26th, while the southern center turned eastward. During this period a SHIP near 53°N, 35°W, reported winds to 50 kn and seas to 23 ft. The southern center departed from the analysis on the 26th with the northern one following on the 27th.

The high pressure that normally sits over the Greenland Ice Cap started drifting southward on the 20th. A trough formed over the Denmark Strait on the 21st, and a LOW was analyzed on the 22d. Late that day three Icelandic ships north of the island were tossed about by 50-kn winds which continued into the 23d. At 1200 that day the LOW was centered near 65°N, 03°W, at 980 mb. The EDITH NIELSEN (60°N, 19°W) had 45-kn winds and 30-ft seas on her starboard bow. A ship north of Ireland was swept by 45-kn winds and 23-ft seas. On the 24th two ships in the North Sea near 53°N, 02°E, were mauled by 60-kn winds, but no seas were reported (fig. 65). The NAUTIK was fishing east of the Orkney Islands when she was hit by 60-kn winds and 39-ft seas. By the 26th neither LOW was significant.

Figure 65.--The LOW is barely visible owing to its high latitude and low Sun angle.

A cold front moved off the Gulf and Southeast coast early on the 25th and stalled as they often do for various reasons. Over the Gulf this is usually the result of the lack of any wind component normal to the front. The same applies over the Atlantic, but as in this

case a large high-pressure area may also have impeded further movement. In this type of situation waves will generally form on the front as they did on the 25th off South Carolina. The storm moved up the coast, deepening as it went. By 1200 on the 27th, the 974-mb center was west of Sept-Isles. Two Canadian vessels in the vicinity of 44°N, 64°W, were on the receiving end of 50- and 55-kn winds. EB07 now named 44007 reported 40-kn winds and 21-ft seas At 1800 (fig. 66) the AMERICAN ARCHER, 100 mi east of Cape Sable, experienced 55-kn winds, 16-ft seas, and 33-ft swells. On the 28th the IMPERIAL BEDFORD outside of Cornerbrook had 60-kn winds. Other ships were finding 40 to 50 kn and seas to 25 ft. On the 29th the storm moved ashore near Godthab, Greenland.

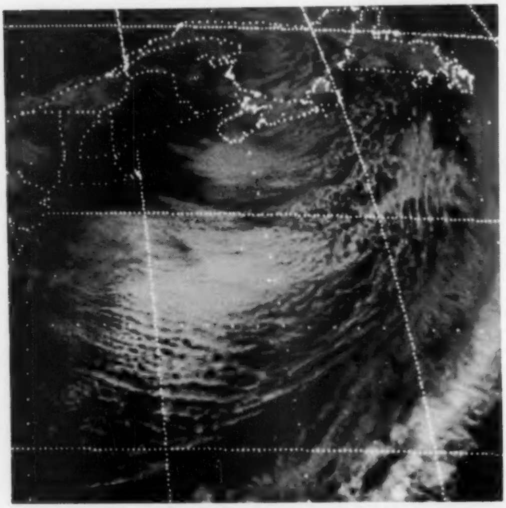


Figure 66.--The buoy 44007 which replaced OWS Hotel is under the unstable cumulus clouds over the Gulf Stream west of the front.

As the LOW above crashed on the Greenland shore, a LOW formed in a trough near Cape Sable. The 1002-mb LOW was near 48°N, 43°W, at 0000 on the 30th. The OGDEN FRASER near 42°N, 46°W, was washed by 50-kn rain-laden winds (fig. 67). The winds were gradually increasing, and on December 1 the 954-mb maelstrom was near 54°N, 35°W. Winds during that period were up to 60 kn and the seas to 30 ft. The DART EUROPE, MANCHESTER CHALLENGE, and

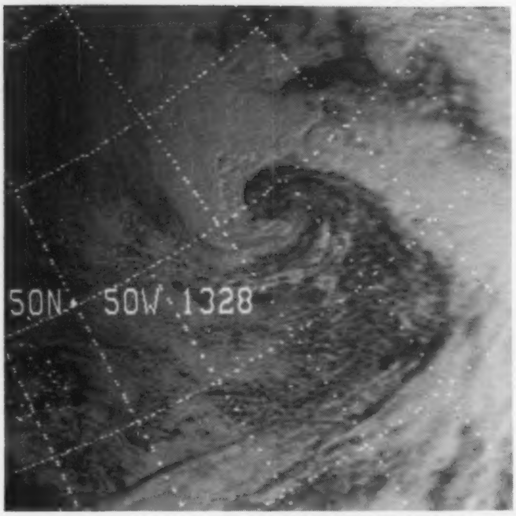


Figure 67.--The OGDEN FRASER was receiving the rain from the heavy clouds along the front south of the LOW.

TROLL PARK south and west of the LOW were among those reporting. On the 2d the central pressure started rising and the circulation spread, relaxing the gradient and the winds. Twenty-foot seas were still found up to 1,000 mi to the south. On the 3d the center turned northwestward, and OWS Charlie was swamped by 25-ft swells. As the LOW approached Kap Farvel on the 4th, it disappeared.

Casualties--The Faeroe Islands cargo vessel STAR SEA (392 tons) arrived St. John's, Newfoundland, on the 18th with a ventilator cap missing due to heavy weather. The 1,600-ton Danish DECIMUS was at Nassau on the 22d and reported containers lost overboard and hull damage from heavy weather. The 2,713-ton laker VIKING pulled out dock mooring fittings, disturbed apron, and struck the knuckle at a dock at Frankfort, Mich., in strong winds on the 21st. The Greek cargo vessel LADY ERA (8,109 tons) went aground on rocks in 11 ft of water at Seven Islands and developed a 12° list. Gale-force winds with 12-ft swells hindered rescue efforts. The 1,439-ton Cypriot freighter SAN GEORGE was blown aground on the 27th at Istanbul.

Rough Log, North Pacific Weather

October and November 1977

ROUGH LOG, OCTOBER 1977--This was a busy month for cyclones. The weather patterns were settling into a winter regime and were stronger and lasted longer but generally had not developed into the large, deep circulations of deep winter. There were two primary storm tracks: one of continental origin that traced a path eastward from over the Tartar Strait into the Bering Sea near latitude 59°N; and the other of maritime nature from south of Honshu to near 45°N, 180°, and then into the western Gulf of Alaska. A secondary track broke off the latter primary track near 40°N, 170°E, and continued eastward before it turned northeastward near 40°N, 155°W.

The mean monthly pressure pattern closely matched the climatic pattern. The Aleutian Low at 993 mb was normally located near 57°N, 150°W. This was 8 mb lower than the climatological value and produced a 9-mb anomaly near the same position. An elongated trough stretched westward to the Tatar Strait, while the southerly trough passed through 40°N, 160°W, and divided the Pacific High into two 1022-mb cells. These two cells were reflected in two plus 3-mb anomaly centers. There was the normal slight ridging over the mountains along the U. S.-Canadian coast.

In the upper air the zonal flow pattern between latitudes 30° and 60°N was normal, but the gradient was more intense, which would produce stronger winds. A LOW was centered over the Bering Strait. This center was connected to two other centers by an east-west trough that stretched into north-central Siberia. The ocean between latitudes 20° and 50°N had positive height anomalies. The area of negative anomalies was between latitudes 50° and 70°N, except south of the Gulf of Alaska where they reached approximately 42°N.

Hurricane Heather was the last tropical cyclone of the season over the eastern ocean. The western ocean hosted four tropical cyclones--typhoons Gilda, Ivy, and Jean and tropical storm Harriet.

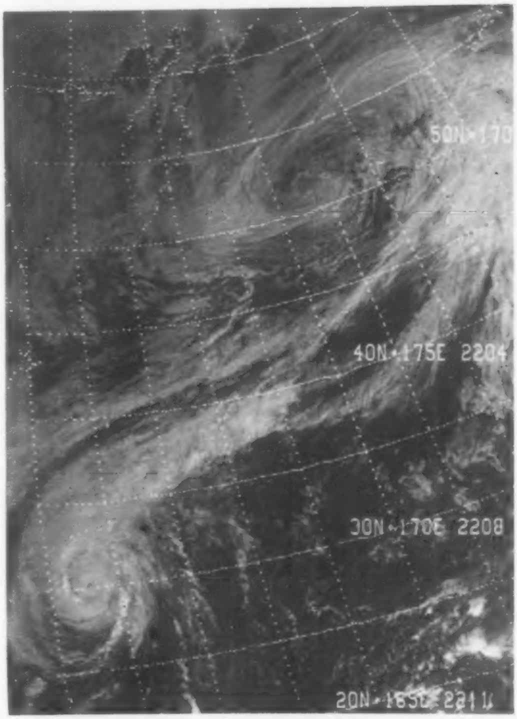


Figure 68.--The extratropical storm is east of Kamchatka with tropical Gilda southeast of Japan. The cloud pattern of the two storms demonstrates the continuity of global weather.

Extratropical Cyclones--The first significant LOW this month formed south of Honshu on the 3d, as a frontal wave. It quickly developed to 996 mb 24 hr later at 1200 on the 4th near 35°N, 146°E. At that time a ship 200 mi northeast of the center reported heavy rain with 40-kn winds. Twelve hours later the ALASKA MARU was about 60 mi north of the center with 50-kn winds and 16-ft waves. A ship about 200 mi south of the LOW had 33-ft seas. Gales continued and at 0000 on the 6th the HEIDE LEONHARDT was passing westward south of the storm with 50-kn winds and 26-ft waves.

Early on the 7th four ships very near the center of the 990-mb storm at 48°N, 165°E, had winds to 56 kn and waves to 30 ft. At this time the storm was deepening rapidly. By 1200 the pressure had plunged to 972 mb. The SAKHALIN, fishing near 53°N, 172°E, was hit by 55-kn winds and 20-ft seas (fig. 68). As the LOW moved over the Bering Sea on the 8th, two Japanese ships reported winds to 55 kn and swell waves to 30 ft south of the storm.

As the cyclone moved toward Bristol Bay, a ship 700 mi to the south fought 33-ft swells on her stern. On the 10th the storm was turning westward over Norton Sound and ending, but the PACIFIC WING still found 50-kn winds and 25-ft seas near 53°N, 176°W. The storm disappeared over the cold water as another LOW formed south of Kodiak Island. This now became the primary storm.

The winds and waves in the far southwest quadrant continued without regard to the change in centers. The CHIKUHO MARU (44°N, 165°W) was sailing into 40-kn gales and 25-ft swells. On the 11th a report from a ship (3FTF) near 59°N, 151°W, indicated 96-kn winds and waves of 33 ft (fig. 69). The PRESIDENT MADISON was pounding into 50-kn winds and 13-ft waves on the 12th. By late on the 13th the LOW dissipated south of Anchorage.

The waters south of Tokyo spawned this storm late on the 10th. It remained only a wave until late on the 12th when the first closed isobar was drawn on the charts. The ALASKA MARU, a good reporter, sent one of the first reports of gale-force winds with 16-ft swells in the northwest quadrant at 0000 on the 13th. Three

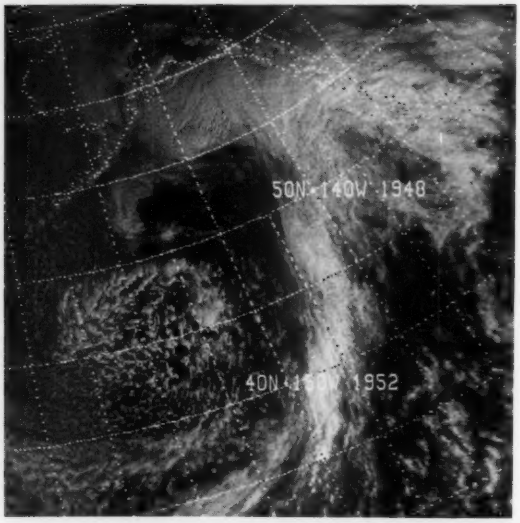


Figure 69.--The intensity of the storm is indicated by the washboard appearance of the clouds over the Gulf.

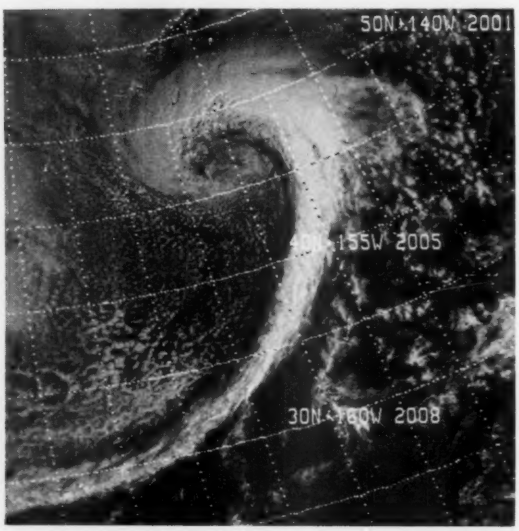


Figure 70.--The storm has a classic appearance with a sharp front extending southward.

other ships reported heavy rain in the northeast quadrant. At 0600 the SANKOGRAIN radioed 54-kn northerly winds also northwest of the 1004-mb center.

By the 15th at 1200 the 986-mb storm was at 45°N, 164°W, and gales of 40 kn with waves up to 20 ft were reported (fig. 70). At 0000 on the 16th the storm was analyzed at 964 mb. The KORO SEA, 240 mi west of the center, was pounded by 60-kn winds. Winds of 35 to 40 kn were measured all over the southern half of the storm. There were three reports of swell up to 23 ft as far away as 750 mi southwest of the center. The ALEUTIAN DEVELOPER was sailing northeastward south of the Alaska Peninsula on the 16th and 17th with winds ranging from 35 to 50 kn and shifting from north to northwest. The land protected her from waves higher than 20 ft. The storm was over the Gulf of Alaska at 0000 on the 17th and Ocean Weather Station Papa was fighting 40-kn winds with 31-ft seas. At 1200 the storm moved ashore.

A wave formed on the 19th on a front that paralleled latitude 37°N off Japan. Another LOW was moving southeastward over the lower Kamchatka Peninsula. By 0000 on the 20th, the LOWs were 976 mb near 50°N, 165°E, and 982 mb near 44°N, 178°E, with a combined circulation. The ASIA ZEBRA was sailing southwestward about 150 mi southwest of the northern center. Her starboard side was pounded by 55-kn winds driving seas and swells of 38 ft. A ship in the warm sector south of the second LOW was sailing into 50-kn southerly winds with 25-ft seas and 36-ft swells.

By 1200 on the 20th the southeastern LOW was the only center of circulation at 964 mb. The TOYOTA MARU found 65-kn winds near 48°N, 170°W, at 1800. The seas were 23 ft and the swells 33 ft. The 960-mb LOW was near 48°N, 161°W, at 0000 on the 21st. The FEDERAL SUMIDA was about 4° latitude to the south with 63-kn winds. Winds of 40 to 50 kn and seas over 16 ft were being reported all around the storm. At this time it was a tremendous storm. Its circulation reached from the Beaufort Sea to latitude 30°N and from the interior of western Canada west to 180°. At 0000 on the 22d, the storm's pressure had dropped to 950 mb near 55°N, 148°W (fig. 71). The EVER PROMOTER, south of the center near 41°N, 142°W, was tossed by 66-kn winds with waves of only 16 ft. A ship about midway toward the center had 30-

Figure 71.--The center of the deep, large storm is on the northwestern side of the clear area. The EVER PROMOTER was miles south near the northern edge of the front.

ft swells. The GREAT LAND was southeast of the LOW at 1200 with 62-kn winds and at 1800 the seas were 34 ft. Her barometer had dropped to 963 mb at 1000. On the 23d the storm stalled over the Gulf of Alaska off the coast and filled rapidly. Three U.S. ships had 50-kn winds in the vicinity of 58°N, 145°W. On the 24th the storm disappeared.

Monster of the Month--Typhoon Ivy was encompassed by a large circulation that resembled an egg with the small end to the north. A low center was analyzed in this north end on the 0000 chart of the 24th. A large HIGH was centered to the east and moving eastward. The storm had a good start from the warm, moist air advected into it from the circulation around Ivy. By 1200 its pressure had dropped to 980 mb. At this time the storm started racing northeastward. The 0000 chart of the 25th showed many reports of strong winds and high seas. Both the PRESIDENT LINCOLN and JEFFERSON were near 43°N, 161°E, with 55-kn winds with seas of 25 ft and swells to 34 ft. The EATON

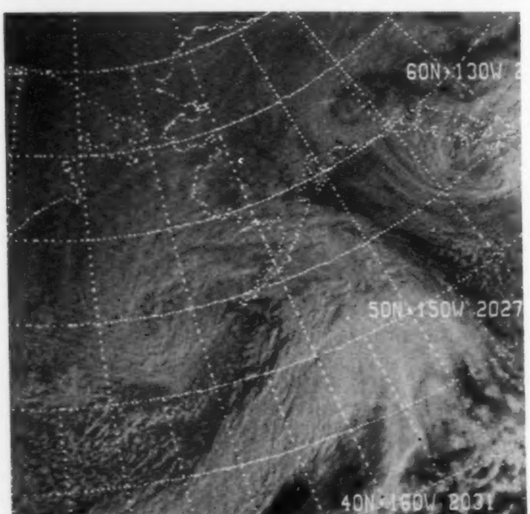


Figure 72.--At 2030 on the 25th, the high clouds on the satellite image show the center of the storm near 55°N, 173°W, and St. Paul Island. It reached a record minimum pressure about 9-1/2 hr later.

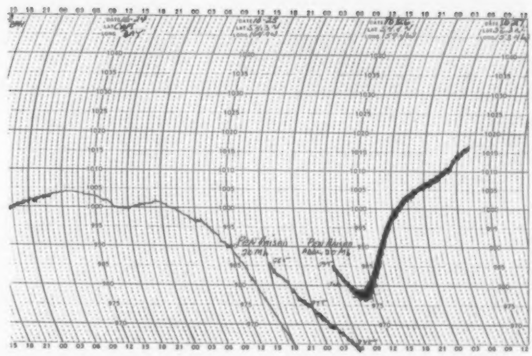


Figure 73.--The barogram from the ALEUTIAN DEVELOPER showing the 937-mb pressure and the pumping action of the pen from gusts and turbulence.

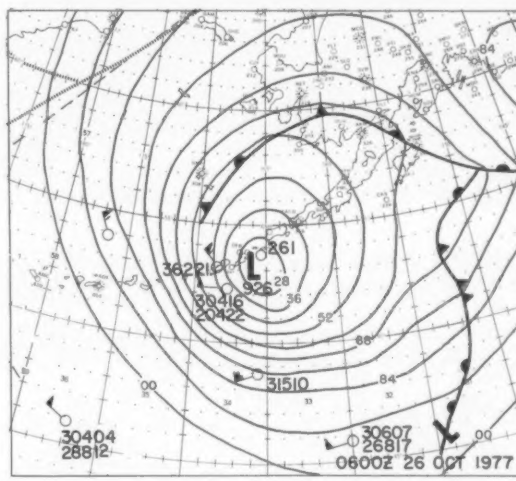


Figure 74.--A copy of the surface chart at 0600/26. The 261 plot near the center is from the report of the VIGILANT.

GLORIA reported fantastic 51-ft swells near 44°N, 158°E. The strong winds continued. Peak winds of 95 kn from the west were recorded at Adak Island at about noon. Several buildings were blown from their foundations. At 1800 the NORTH STAR III had 60-kn winds gusting to 70 kn. On the 26th at 0000 three ships reported winds of 70 kn or more, with the MORI MARU calling the swells 56 ft, while another ship claimed 46 ft. The ALEUTIAN DEVELOPER at 54°N, 162°W, reported 41-ft waves (fig. 72). Six hours later the swell was 51 ft. She had winds over 60 kn from 1800 on the 25th through 0900 on the 26th. They calmed to 20 to 40 kn for 24 hr, but were again 65 kn at the 0900 and 1200 observations on the 27th. It was not until after 0600 on the 27th that the swell dropped below 30 ft. She recorded a low pressure of 937 mb at 0900 on the 26th. The pen had to be raised twice for a total of 40 mb. The LOW dropped to 933 mb near 54°N, 168°W. At 0020/26 St. Paul Island re-

Figure 75.--High waves battered this travelers' wayside at Lincoln City, Ore., on the 29th. One person was killed as a direct result of the storm. Wide World Photo.

corded a minimum sea-level pressure of 936.8 mb (27.64 in) on the barograph. At 0600 the NORTH STAR III was at 54°N, 164°W, with her pressure showing 936 mb (figs. 73 and 74). The VIGILANT near Dutch Harbor reported a minimum pressure of 926.1 mb (27.35 in)--a new all-time record low pressure reading for Alaska. At King Cove some building materials were lost with other wind damage.

The high winds and waves continued until the 28th when the storm slowed over the Gulf of Alaska as its pressure rose. A frontal wave guided by the zonal flow south of the LOW crashed into the Washington-Oregon coast (fig. 75) on the 30th. Another wave hit the coast on November 1. A ship off Portland was battered by 50-kn winds. Winds gusted to 50 kn along the coast of Oregon and Washington. A gust of 77 kn was clocked at Smith Island, Wash., and gusts over 105 kn were recorded at Rattlesnake Ridge, Wash. On the 2d the winds diminished.

Tropical Cyclones, Eastern Pacific--Hurricane Heather was first detected about 300 mi southwest of Mazatlan on the 4th. She was intensifying and heading northwestward. The following day Heather attained hurricane strength as she moved between Clarion and Socorro Islands. Winds near her center climbed to 75 kn for a short while. Heather retained her hurricane-force winds until late on the 6th when she fell back to tropical storm intensity about 240 mi south-southwest of Pt. Eugenia, Baja California. On the 7th Heather, now a depression, began to break up about 70 mi west of Pt. Eugenia.

Heather's large circulation triggered showers and thunderstorms over the southwestern United States. Several locations in Arizona received 1- to 2-in falls in a short period of time, causing flash floods.

Tropical Cyclones, Western Pacific--Gilda developed on the 3d midway between Wake Islands and Guam. She headed northward then northwestward. By the 5th she had crossed the 20th parallel, near 154°E, and was at typhoon strength. Gilda remained at minimal typhoon strength into the 6th but dropped back to tropical storm intensity as she crossed the 25th parallel near 149°E. Late on the 7th and on the 8th, winds climbed back up to 65 kn as Gilda began to recurve toward the northeast. At 0000 on the 9th the JFLI and the PRESIDENT TAFT encountered 40-kn winds in 16- to 20-ft swells. The following day the PRESIDENT TAFT and the JBSL reported 40-kn winds in seas up to 20 ft. Gilda was turning extratropical on the 10th as she headed east-northeastward past 165°E at about 43°N.

By midday on the 10th Gilda had become extratropical, but ships found little change in the winds and seas and heavy rain continued. On the 11th the storm was 992 mb near 43°N, 180°. On the 12th the CHESTNUT HILL was about 450 mi southwest of the center with 45-kn winds and 15-ft seas. The PRESIDENT TAFT was keeping pace with the storm and at 1200 was only a few miles south of the center with 16-

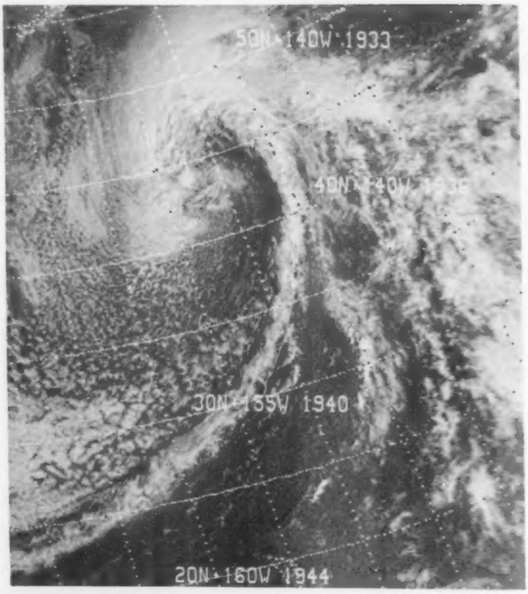


Figure 76.--Gilda has quite a different appearance now than in figure 68, but she is just as vicious a storm and larger in area.

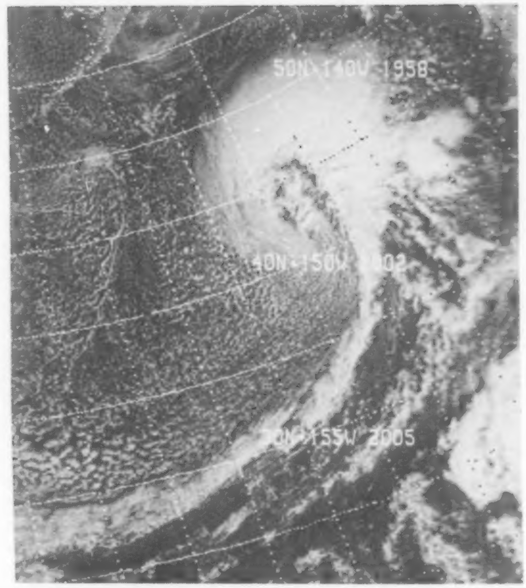


Figure 77.--The more vicious storms of this month either originated as tropical cyclones or were associated with their environment.

ft swells.

The storm turned northeastward on the 13th and made things even tougher for the PRESIDENT TAFT, who suffered 60-kn winds, 33-ft seas, and 36-ft swells at 1800 (fig. 76). On the 14th the winds were 55 kn, the seas had dropped to 12 ft, but the swell remained at 36 ft. The SEA-LAND COMMERCE was north of the storm near 47°N, 154°W, contending with 65-kn typhoon-force winds and 16-ft waves. Five ships reported winds of 50 kn or more in the Gulf of Alaska. At 1200 on the 14th the central pressure had again reached 958 mb. A ship 100 mi northwest of the center measured 966 mb. The TAFT was now 750 mi south of the center of the storm with only 30-kn winds, but the seas were 16 ft and the swells 26 ft. At 1200 on the 15th the GREAT LAND was near 56°N, 140°W, and headed toward Cook Inlet with 60-kn winds out of the south. Her pressure dropped to 979 mb. On the 16th the storm crossed the coast near Valdez and disappeared.

Harriet was spawned on the 16th near 15°N, 135°E. She moved northwestward until the 17th when she recurved northward. By this time Harriet was a tropical storm. On the 18th the OXIT 150 mi northwest of the eye and the JEKH some 80 mi east of the eye ran into 35-kn winds. Seas were running 20 ft to the northwest and 25 ft to the east. Maximum winds were 55 kn near the center on the 18th. This was Harriet's peak intensity. She turned toward the northeast on the 19th. By the 20th she turned eastward and started to become extratropical.

Extratropical Harriet continued an easterly movement and at 0000 on the 21st was only a weak 1004-mb LOW. A building HIGH was following across Japan fast on the heels of the developing storm. The DOLLY TURMAN near 34°N, 149°E, was nearer the HIGH than the LOW, but the winds were 55 kn out of the northeast. The LOW was racing eastward at 45 kn. By 0000 on the 23d the 976-mb center was at 41°N, 158°W. As it passed north of the ORIENTAL EDUCATOR, her winds increased to 68 kn. There were eight reports of winds 40 kn or greater and waves as high as 25 ft.

At 0000 on the 24th, the storm's central pressure had dropped to 944 mb--probably lower than when it was a tropical storm (fig. 77). Shipping was really getting battered by high winds and waves. The HARFLEUR (39°N, 142°W) had 70-kn winds and 30-ft waves, while the VLADIMIR MAYAKOUSKIY (40°N, 145°W) had 62 kn and 39-ft waves. Many other ships reported winds in the 50-kn and seas in the 20-ft range. At 1200 the storm was still raging. The USNS S. P. LEE near 43°N, 138°W, was ravaged by 60-kn winds with incredible 46-ft seas and 52-ft swells. The SEA-LAND MCLEAN registered a low 947.5 mb on her barometer at 49°N, 141°W (fig. 78).

On the 25th the highest winds were 70 kn and the highest waves 41 ft. It was still a vicious storm. Late that day the storm started filling as it approached Sitka on the coast. By 1200 on the 26th the 983-mb center disappeared as another storm moved eastward across the Alaska Peninsula.

While Harriet was turning extratropical, Ivy was coming to life some 800 mi to the south. Ivy meandered for several days before organizing and heading northeastward. On the 24th she reached typhoon intensity near 21°N, 150°E. Ivy crossed the 25th parallel near 155°E late in the day. The following day winds climbed to 90 kn near her center, and this was her peak intensity. After this winds began to diminish and cold air began to intrude into Ivy's circulation. She

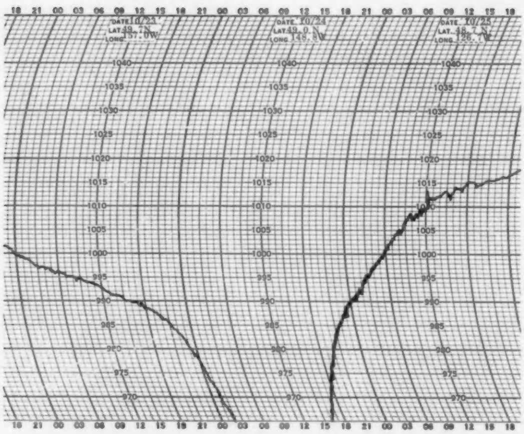


Figure 78.--The barogram pen was not reset on the SEA-LAND MCLEAN, so the 947.5-mb pressure was not shown.

started to turn extratropical.

Tropical storm Jean was a short-lived system that formed at the end of the month. First detected near 19°N, 157°E, on the 28th, Jean was moving northward. She developed rapidly and swung toward the northeast. By late on the 29th Jean was at typhoon intensity. These 65-kn winds lasted less than 24 hr as Jean fell back to tropical storm strength near 25°N, 159°E, at 1200 on the 30th. She then drifted westward for 24 hr before falling apart completely. On the 2d of November (fig. 79) she attempted a comeback. Jean regenerated near 26°N, 146°E. She never got beyond tropical depression stage, and this lasted for only one day.

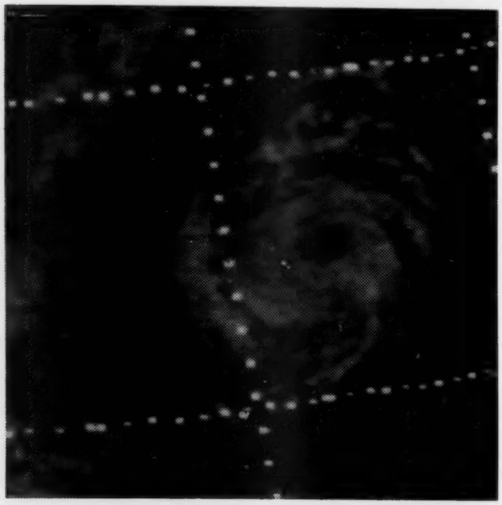


Figure 79.--Jean tried for a comeback on November 2.

Casualties--The 19,713-ton Panamanian MARITIME ACE requested survey of heavy weather damage to shell plating at Achi Innoshima. On the 18th the Indian bulkcarrier ALEXANDRA N. returned to Victoria with heavy weather damage. The 35,545-ton Greek-registered PANTELIS A. LEMOS was due Vancouver with heavy weather damage. The barges GALENA and NORTON SOUND in tow of the tug CLARION from Dutch Harbor were cut adrift in a heavy gale on the 26th. The barges were later located at Moffett Point, 25 mi north of Cold Bay.

The American containership PRESIDENT JEFFERSON (21,467 tons) sustained container damage from heavy weather and high winds. She was due Seattle on the 29th. The British ALMERIA STAR (7,615 tons) was at Kobe on the 31st with heavy weather damage. The American cargo vessel ILLINOIS (13,156 tons) diverted to Honolulu on the 27th when containers toppled in heavy weather and vessel lost power. The American crabber EAGLE (176 tons) sank in heavy weather in Alaska waters on the 26th. All crewmembers except the Master were found alive 10 days later.

ROUGH LOG, NOVEMBER 1977--Both oceans were anomalous with the normal climatological patterns this month. This is an indication that meteorology is a continuous phenomenon and not an isolated condition. Like the North Atlantic the concentration of storm tracks was shifted eastward. In this case the primary track originated in midocean along latitude 35°N and moved toward the Gulf of Alaska. Storms from the vicinity of Japan were widely scattered and traveled in various directions. Normally, the concentration of paths is from Japan to the Bering Sea and south of the Aleutians into the Gulf of Alaska.

The Aleutian Low was normal at 1002 mb near 53°N, 160°W. A trough oriented south out of the Low split the Pacific High into two 1023-mb centers--33°N, 133°W, and 33°N, 165°E. These centers were 3 to 5 mb higher than climatology. There was a large negative anomaly centered on 160°W from the Aleutians to latitude 20°N. A positive 4-mb anomaly was centered off the California coast, and a positive 9-mb center was southeast of the Kamchatka Peninsula. These two positive centers reflected the higher pressures in those areas and the abnormal paths of the cyclones.

The upper air pattern at 700 mb had an anomalous LOW over Bristol Bay with a sharp trough south along longitude 170°W. As with the surface, this split the HIGH into two centers.

There were two typhoons, Kim and Lucy, over the western ocean.

Extratropical Cyclones--This LOW formed south of Kodiak Island in a trough associated with another LOW over the Bering Sea on the 5th. The MARITIME FORTUNE was off Portland, east of a sharp ridge ahead of the front, with 56-kn winds on the 6th. The ALASKA was near Yakutat with 55-kn winds. At 0000 on the 7th, the 991-mb LOW had crossed the mountains into northern Canada, and another 994-mb center was near Valdez. The MOBIL MERIDIAN and NEWARK were south of the Valdez center with 45- and 50-kn winds and 25- and 26-ft swells, respectively. Other ships found

40-kn winds and 20-ft waves. The LOW was stationary over Valdez, and on the 8th the GALVESTON headed toward Seattle contributed a 50-kn wind report. By the 9th the storm no longer existed.

A LOW out of Manchuria moved over the Sea of Okhotsk on the 6th. On the 7th another LOW formed at the point of occlusion on the east coast of the Kamchatka Peninsula. It moved slowly eastward and at 0000 on the 8th was 984 mb near 56°N, 172°E. The EASTERN RELIANCE at 50°N, 168°E, had 45-kn winds with 14-ft seas. Ahead of the front at 54°N, 172°W, the LIONS GATE BRIDGE had 44-ft swells pounding her portside (fig. 80). The ALEUTIAN DEVELOPER (56°N, 158°W) fought 55-kn southerly winds and 20-ft seas 24 hr later. In the southwest quadrant there were 40-kn winds and 16-ft seas. On the 9th at 1800 the GALVESTON had 60-kn southeasterlies near the Alaska coast. Winds of 40 kn and seas of 16 ft were still southwest of the center. The storm crossed the Alaska Peninsula into the Gulf of Alaska on the 9th. On the 10th it curved northward and dissipated over the mountains of the Alaska-Canada border on the 11th.

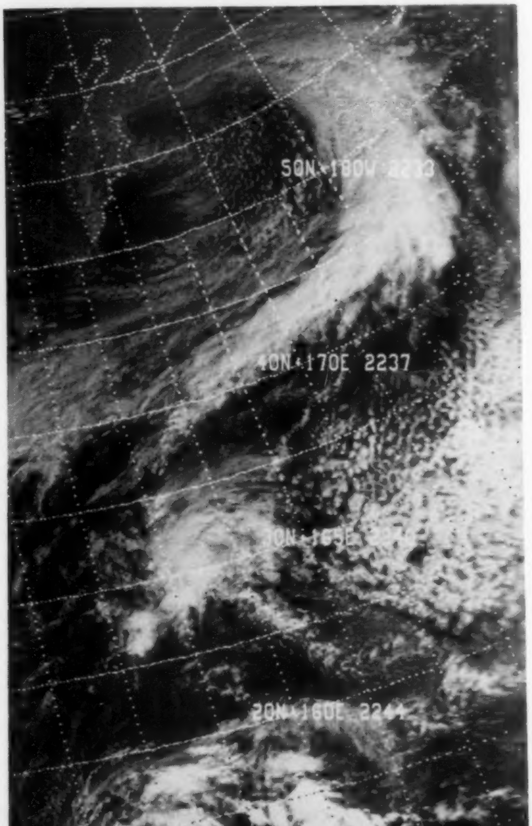


Figure 80.--The atmospheric circulation can again be followed by the cloud pattern from typhoon Kim in the south to the extratropical storm off Kamchatka.

This frontal wave formed between two high-pressure cells on the 7th near 34°N, 167°W. The pressure gradient between the LOW and the western HIGH was supporting 40-kn winds and 24-ft seas by 1200 on the 7th as found by the PRESIDENT JEFFERSON. By 0000 on the 8th the LOW was near 41°N, 155°W, as the eastern HIGH retreated rapidly eastward. Winds on the western side of the LOW continued at 40 to 45 kn with one report of 20-ft seas. On the 9th the PRESIDENT MADISON off Sitka had 50-kn winds. The LOW moved onto Vancouver Island and died.

The Yellow Sea produced this storm. It began as a frontal wave on the 7th, the third one to start on this day. It raced across the Sea of Japan and on the 9th was over the Kurile Islands. A ship south of the center and near the cold front had 16-ft seas. Another near Ostrov Kunashir reported 50-kn winds. At 1200 the SUCHAN (50°N, 155°E) was holding her position in 50-kn winds and 26-ft seas. On the 10th a U.S.S.R. ship in the Gulf of Shelekhov in the Sea of Okhotsk had to halt operations in 80-kn easterlies. The KATHRYN MARU was 500 mi south of the center at 1200 with 26-ft seas. At this time another center formed to the east, and by the 11th this LOW was gone.

This LOW was frontal generated on the 10th near 35°N, 146°E. It raced northeastward, still a small storm. At 1200 on the 11th it was 998 mb near 46°N, 170°E. Four ships south and west of the center reported 48- to 54-kn winds and seas up to 20 ft. On the 12th a ship near Mys Lopatka was swamped by 28-ft seas. Late in the day the PRESIDENT MADISON near 50°N, 176°E, was headed into 60-kn winds and 25-ft swells. On the 13th two ships southwest of the center had 50-kn winds, and the seas were reported as high as 25 ft. At 1200 the 966-mb center was over the Alaska Peninsula. At 1800 the SINCLAIR TEXAS was headed southeastward into southerly 60-kn winds and 30-ft waves (fig. 81). Ocean Weather Station Papa was fighting 54-kn winds and 18-ft seas. By the 14th another LOW had absorbed the circulation, but this had little to do with the actual weather. Over a half dozen ships reported winds between 45 and 60 kn on the 14th with seas to 30 ft. On the 15th the weather improved, and the storm was no longer a problem.

Late on the 14th a LOW developed off the Kamchatka Peninsula. At 1200 on the 16th it was 970 mb near 55°N, 173°E. The WORLD SUPREME was north of Unimak Island and was ravaged by 86-kn winds out of the southeast (fig. 82). Two ships south of the center had 60-kn winds and 33-ft swells. The center was moving very slowly. The INACHUS STAR at 52°N, 170°E, churned into 50-kn winds and 33-ft swells.

Figure 81. --By 2000 of the 13th the LOW has moved to near 53°N, 145°W.

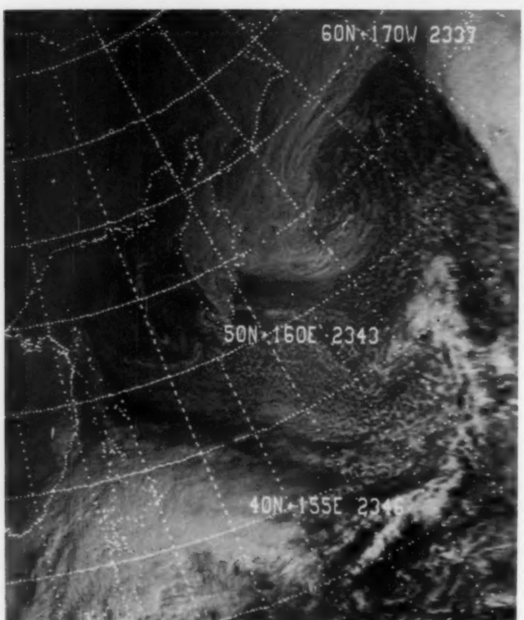


Figure 82. --The WORLD SUPREME was many miles east of the storm under the heavy clouds on the right of the picture.

Late on the 17th this storm was absorbed by the one below.

A front stretched unbroken from the northern California coast to Taiwan. On the 0000 chart of the 15th a wave was analyzed near 33°N, 149°E, using the observations from a Japanese and a German ship. The frontal wave was under strong westerly zonal flow aloft and raced to 175°W in 36 hr. Along the way several ships reported gales and waves to 23 ft. The GEORGIANA, near 36°N, 174°W, about 150 mi south of the center, was battered by 55-kn winds with 49-ft seas and swells. At 0600 on the 17th, the ILLINOIS and another American ship had 50- to 55-kn winds and 30- to 33-ft swells, not far from 41°N, 168°W.

On the 18th this storm combined with the previous storm near 50°N, 170°W, at 966 mb. The EURYALUS and the GEORGIANA were near 36°N, 177°W. The winds were 45 kn and the seas and swells 36 to 43 ft. At 0000 on the 19th the storm was still 966 mb near 55°N, 180° (fig. 83). The LOW was stationary for the next few hours over the Bering Sea. Very ships were reporting. On the 20th at 1200, the ALEUTIAN DEVELOPER was sailing northeastward near 57°N, 154°W, with 50-kn easterly winds and 30-ft swells. On the 21st the storm was moving northwestward toward oblivion.

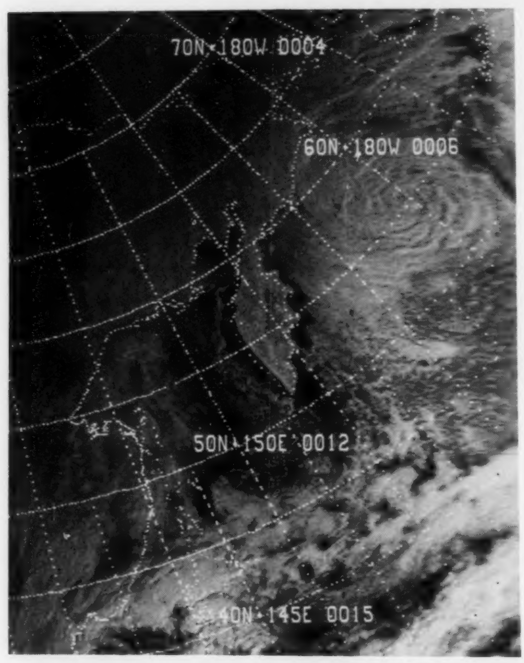


Figure 83. --The satellite verifies the analysis.

Late on the 15th this storm formed over the Yellow Sea. As the last frontal wave, it raced eastward under the strong upper air flow. Along the way it produced heavy rain and some gales. On the 19th it was 995 mb

near 37°N, 179°W. The FUJISAN MARU was caught near 32°N, 178°E, with 45-kn gales and 15-ft waves. On the 21st the storm reached latitude 46°N and was turning northwestward. A ship near 48°N, 150°W, which was east of the center, had 26-ft swells pounding her portside on her southerly track. North of the LOW two ships had 40-kn gales and 20- to 24-ft seas. At 1200 ocean buoy 17 measured 40-kn gales and 25-ft seas. Late on the 22d, the storm was overtaken by the next storm.

This LOW formed over midocean near 40°N, 173°E, on the 21st. At 0000 on the 22d it was 977 mb near 41°N, 167°W (fig. 84). The GOLDENROD was near the center at 41°N, 170°W, with a pressure of 980 mb, 70-kn winds, 26-ft seas, and 41-ft swells. At 0600 the UIWK reported 82-kn winds with 20-ft seas a few miles south of the center. At 0000 on the 23d the 974-mb center was rolling toward the northeast and hit the SANTA MONICA MARU with 50-kn winds and 24-ft swells. At this time the storm's circulation covered the ocean north of 25°N and east of 175°E. Winds up to 50 kn and swells to 33 ft continued. The OVERSEAS NATALIE was sailing eastward near 47°N, 169°W, into quartering 34-ft swells. The PHILADELPHIA (55°N, 141°W) northeast of the center was bounced by 30-ft swells. The LOW disappeared south of Seward, Alaska, on the 26th.

Figure 84. --The storm moved 3° longitude in 4 hr.

This storm formed near 36°N, 173°E, around the remnants of an old weak front. By the 25th it had organized, and the IRVING WOOD and POST CHASER had winds of 50 kn or better and seas as high as 30 ft west of the storm. Later on the 25th another LOW formed west of this one, and a ship was caught in 50-kn winds and 24-ft seas. In the southerly quadrant between the two centers there was another report of 26-ft swells. The western LOW was to become the stronger of the two. At 0000 on the 26th, the PACPRINCE was 200 mi southwest of the second LOW (36°N, 177°W) where she caught 39-ft swells with 50-kn winds. Twelve hours later ships reported 36-, 30-, and 24-ft swells about 600 mi west of the storm. The highest winds were 55 kn. The first LOW was racing northeastward, and a ship at 38°N, 155°W, found 50 kn and 24-ft seas and swells.

The LOWs were following each other as on a race track. The first LOW had passed too far east of the JAPAN BEAR to affect her, but she was caught by the second storm with 50-kn winds and 24-ft waves. The first storm dissipated late on the 27th as it hit the British Columbia shore. The second storm was also weakening rapidly, but the PRESIDENT JEFFERSON measured 26-ft swells as the LOW passed southeast of her. The CHEVRON MISSISSIPPI was the last to feel the rath of 45-kn winds and 15-ft seas as the storm moved ashore south of Sitka.

Tropical Cyclones, Western Pacific--Typhoon Kim was first detected on the 6th about 500 mi east-southeast of Guam. Two days later she moved across Guam as a tropical storm. It was about this time that Kim first reached typhoon strength. She continued to intensify on her west-northwestward trek. Kim crossed the 15th parallel late on the 9th near 136°E. However, she reversed her path and headed toward the west-southwest and then westward. Winds near her center were now estimated at up to 120 kn. Kim was fast becoming a threat to Luzon (fig. 85). Late on the 13th she car-

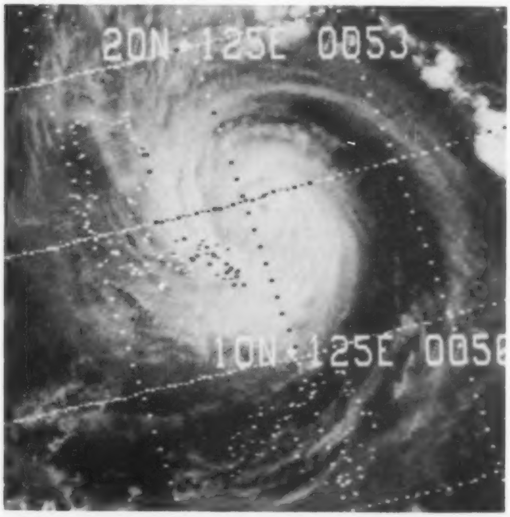


Figure 85. --Kim is approaching Luzon with 120-kn winds early on the 13th.

ried her roaring winds and torrential rains across Luzon Bay and inland over southern Luzon. Early on the 14th she passed north of Manila and out into the South China Sea. Kim dropped below typhoon strength later in the day. She then swung northward and on the 16th recurved eastward through the Luzon Strait as a depression.

Kim brought death and destruction to the northern Philippines. The typhoon affected some 10,834 Philippine families of which 3,500 were evacuated and given temporary shelter. A total of 5,035 residential buildings were totally damaged, and an estimated 3,726 were partially damaged. Conservative estimates of property and crop damage were put at $26 million. An estimated 47 people died, not including the victims of the hotel fire in Manila. Most were drowned in swollen rivers or struck by falling trees. Two small Philippine freighters were driven aground by the storm.

The worst typhoon-related disaster occurred in the seven-story Hotel Filipinas in Manila. A fire, presumed to have been started by a candle in the powerless hotel, was fanned by winds from the typhoon and swept through the seaside hotel. Some 44 people were killed, mostly foreign tourists. Firemen battling the blaze saw water from their hoses blown back in their faces by the force of Kim's winds. In other areas some 7,000 families had to flee their flooded homes, and the death toll is at least 19.

Toward the end of the month typhoon Lucy was born among the Caroline Islands. She started just west of Ponape on the 28th. As a depression, she traveled westward through the southern part of the chain. By the time she reached Yap Island on December 1, Lucy was a tropical storm. Her course had shifted toward the west-northwest. Lucy blossomed on the 3d (fig. 86), and she reached typhoon strength early that day. Before the day was over, 120-kn winds were roaring around her center, which was approaching the 15th parallel near 128°E. She was recurving before reaching the Philippines. Winds near her center remained at 100 kn or more into the 5th, while gales extended 200 to 300 mi from her eye. Even when she began to weaken, Lucy remained potent. On the 6th the ATKM some 400 mi to the southwest of her center encountered 55-kn winds. By this time Lucy was heading due eastward. She continued to weaken as she crossed the 150th meridian near 22°N late on the 7th.

Casualties--The 14,000-ton American cargo vessel MAINE lost containers overboard in heavy weather on a voyage for Los Angeles. The British-registered SILVERDON (22,906 tons) arrived Chiba with heavy weather damage.

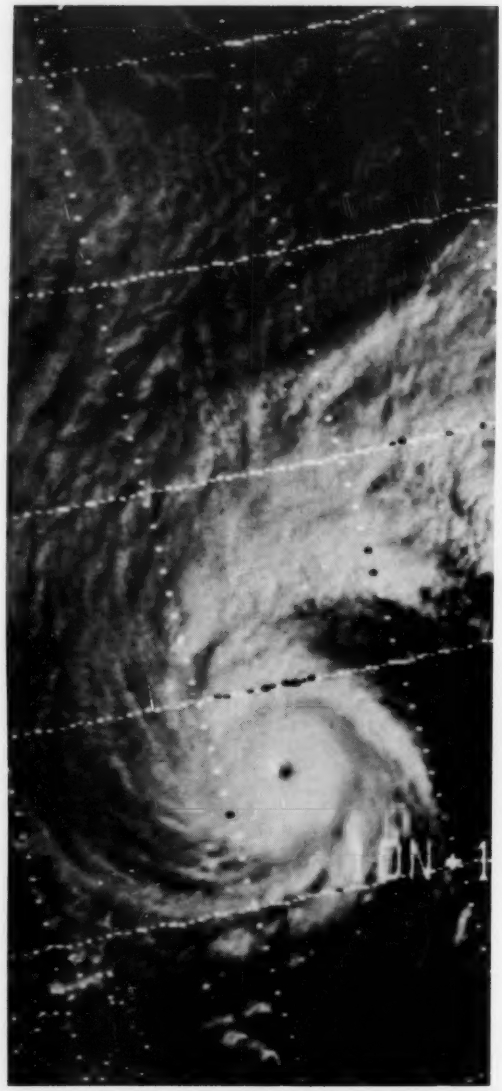


Figure 86. --Lucy is nearing tyhoon strength in this textbook image late on December 2.

Marine Weather Diary

NORTH ATLANTIC, FEBRUARY

WEATHER. Usually the weather over the North Atlantic during February is a continuation of the storminess characteristic of January, and there are years when February weather is the most severe of winter. The average pressure distribution remains quite similar to that of January. The Icelandic Low fills to 1004 mb and is located near 60°N, 40°W. The central pressure of the Azores High drops to 1021 mb near 32°N, 22°W. This reduction in the average north-south pressure gradient is caused both by LOWs being less intense on the average during February, and by the more frequent appearance toward the advent of spring of a blocking HIGH at higher latitudes.

WINDS. Over most of the ocean north of 40°N, the prevailing winds are westerly. The winds over the Norwegian Sea are variable. North of 60°N, between Greenland and Norway, the winds vary about equally from westerly to southerly. West of the Bay of Biscay, the winds are variable. Between 25° and 40°N, the wind direction favors the southwest quadrant in the Atlantic. The direction along the Atlantic Coast of the United States is northwesterly to variable off Florida. Over the Gulf of Mexico it is northerly to southeasterly. Westerly to northwesterly winds dominate the Mediterranean Sea. Force 3 to 5 winds are the most common except off the coast of the Middle Atlantic States, where force 4 to 6 winds prevail. In the ocean bounded by approximately 45°N, 30°W, the Denmark Strait, and the Labrador Sea, force 5 to 7 prevail. The "northeast trades," 25°N to the Equator, blow 65 percent of the time with speeds of force 3 to 5.

GALES. Winds of force 8 or greater occur over 20 percent of the time in an area south of Iceland to south and east of Greenland to the Labrador Coast north of Belle Isle. Another area of gale-force winds is east of Newfoundland, centered about 48°N, 36°W, and 5° latitude in radius. Another area is over the Gulf of Lions. The 10 percent occurrence line extends from about Cabo Finisterre to about 500 mi off Cape Hatteras where it turns northeastward to parallel the coast.

EXTRATROPICAL CYCLONES. This month LOWs form most frequently 150 to 250 mi off the East Coast, from Cape Hatteras northeastward to about the latitude of Cape Cod. This is part of a large area of cyclogenesis that extends from the Gulf Coast of the United States to the Bay of Fundy. Another major area of cyclone development and the path they follow is from the Grand Banks northeastward to Iceland. There also is a primary track northward from Newfoundland to southern Greenland, where it splits into the Labrador Sea and toward Iceland. Other tracks are over the northeastern ocean from west of Ireland toward the Barents Sea, from the English Channel across the Gulf of Finland, and from the Gulf of Lions southeastward across the Mediterranean Sea. The Gulf of Genoa is also a favorite area of cyclogenesis.

SEA HEIGHTS. Seas 12 ft or higher can be expected 10 percent of more of the time north of a line from a couple of hundred miles east of Cape Hatteras to Cape Finisterre, Spain. On the Mediterranean, 10-percent frequencies lie inside an ellipse stretching from Barcelona, Spain, to Crete and then northwestward to Sicily, Sardinia, and the Gulf of Genoa. Another small area of 10-percent frequency lies between Crete and Turkey. The coast of Colombia still hosts a 10-percent line off Barranquilla. An area of over 20 percent is located off the central coast of Norway. The highest frequencies of greater than 30 percent are found over a triangular area between 57°N, 43°W; 45°N, 42°W; and 62°N, 13°W; and in the Denmark Strait.

VISIBILITY. The frequency of low visibility (less than 2 mi) reaches 10 percent or more from Halifax, Nova Scotia, northeastward to a point near 50°N, 40°W, and then northwestward to near Cape Mercy. It also reaches 10 percent on the southeastern North Sea and over the waters around the Faeroe Islands and eastern Iceland. The frequency increases to more than 20 percent inside a coastal region from Cape St. John, Newfoundland, to Resolution Island and then southward to Ungava Bay, and over the Norwegian Sea north of about 72°N.

NORTH PACIFIC, FEBRUARY

WEATHER. February weather in general can be as rough as any month of the year over the middle and higher latitudes. The average central pressure of the Aleutian Low is 1000 mb and is near 51°N, 172°E. The subtropical Pacific High is 1020 mb and centered near 31°N, 138°W. A ridge of high pressure extends eastward from the central China coast. The 1033-mb Siberian High is centered over western Mongolia. The weather regimes are controlled by these three features.

WINDS. Westerly winds prevail over much of the ocean north of 30°N and west of 180°. Northerly winds dominate the East China Sea. Winds are variable over the central Aleutians, southeasterly over the western Aleutians, and easterly near the Pribilof Islands. From the Gulf of Alaska southward to near 40°N and east of 180°, winds are mostly southerly to southwesterly, although other directions are common during the frequent passage of LOWs. Over the extreme northern Gulf of Alaska, the prevailing winds are easterly, and northerly winds are very pronounced over the Bering Sea north of 60°N. The average speed of winds north of 30°N is force 4 to 6, although east of Honshu the wind blows at force 6 or 7, 41 percent of the time. The "northeast trades" extend northward to more than 20°N over most of the western and central ocean and to 30°N over eastern waters; south of 20°N, these winds are very steady. The wind speeds in the trades range from force 3 to 5. The "northeast monsoon" is steady over the South China Sea and the Philippine Sea south of 30°N and west of 150°E. Winds are quite variable over the eastern North Pacific between 30° and 40°N, southwesterly over the east-central ocean be-

tween 30° and 45°N, and variable over west-central waters between 25° and 30°N, and 135°E and 180°. Wind speeds over these areas usually average force 4. Northerly winds predominate over the Gulf of Tehuantepec, and in 71 percent of the observations they range between force 2 and 6.

GALES. The frequency of gales near and above 10 percent affects most noncoastal areas south of the Aleutians and north of a line from the waters southeast of Honshu to a point south of the Queen Charlotte Islands and west of Washington State. A maximum incidence of over 20 percent is found over a 200-mi-wide band 600 to 1,000 mi southeast of the southern tip of Kamchatka, an area east of northern Honshu near 37°N, 155°E, and south of the Gulf of Alaska near 52°N, 145°W. Gale-force northerly winds are encountered more than 10 percent of the time by vessels plying the Gulf of Tehuantepec off southern Mexico. These high winds occur when strong northers from the Gulf of Mexico funnel across the isthmus to the Pacific. In extreme cases, they may be felt more than 200 mi out at sea.

EXTRATROPICAL CYCLONES. The storms predominantly follow a northeasterly track. The principal areas of cyclogenesis are off Hokkaido, the East China Sea, about 600 mi south of Unimak Island, and about the same distance southwest of Vancouver Island. Secondary tracks converge 350 mi east-northeast of Hokkaido and head east-northeastward toward the Rat Islands in the western Aleutians. A primary track extends northeastward from the East China Sea to the waters south of the western Aleutians and then runs parallel to that island chain to the Gulf of Alaska. The passage of LOWs over the Gulf of Alaska along the track described above and the one entering from the southwest is more confined to the western portion of the Gulf. The storm path approaching Vancouver Island from the southwest does not contain a maximum concentration of individual cyclones until it reaches a point 600 mi from that island.

TROPICAL STORM activity is at the annual minimum during February. On the average, one can be expected every 4 yr over western waters. As in the other winter months, the principal region of cyclogenesis is east of the central and southern Philippines. Two out of every seven February tropical storms has reached typhoon intensity in the past.

SEA HEIGHTS. Seas of 12 ft or more are encountered from 10 to 20 percent of the time over most of the ocean area between latitudes 30° and 52°N from 140°W to 145°E. A small area with a similar frequency lies over the waters bounding Taiwan where the "northeast monsoon" blows strongly and steadily. Areas of 20- to 30-percent frequency extend between latitudes 44° and 49°N from 172°E to 153°E, and farther southeast 100 to 200 mi around a line drawn from 35°N, 165°E to 40°N, 175°W.

VISIBILITY. Areas of limited visibility (less than 2 mi) occur in more than 10 percent of the observations north of a line drawn from the Yellow Sea through the Sea of Japan, south of Hokkaido, and then east-northeastward to the Alaska Peninsula. A maximum frequency of over 30 percent surrounds the waters around Ostrov Paramushir, south-southwest of Kamchatka.

NORTH ATLANTIC, MARCH

WEATHER. March is a transition month. The weather retains many of the wintry aspects of January and February and at the same time begins to exhibit some features typical of spring. During the first part of March, the weather is generally a continuation of winter conditions, gradually approaching springlike characteristics near the close of the month. However, wide variations from the climatic averages may be expected, and this pattern is not always the rule. The Icelandic Low (1005 mb) rests southeast of Kap Farvel near 58°N, 40°W, while the Azores High contains two 1020-mb centers southwest of the Azores near 27.5°N, between 35° and 42°W.

WINDS from westerly quadrants generally prevail over the major part of the western North Atlantic north of 30°N. Northerly or northeasterly winds blow more often over the waters between southern Greenland and western Iceland than any other winds from the four cardinal and four intercardinal points of the compass. Winds shift to a southerly component as one moves eastward from 35°W and to variable in direction over the Norwegian Sea east of 5°W. Near the coasts of Morocco and Portugal, northerly winds predominate. South of 30°N, the "northeast trades" are the dominant winds over most of the ocean with few exceptions. East of the Florida coast to about 68°W, wind directions are southeasterly to southerly. There is a strong tendency for easterly and southeasterly winds over the Gulf of Mexico. Over the Mediterranean, westerly to northwesterly winds prevail. For the month as a whole, winds of force 4 to 6 prevail north of 40°N (north of 35°N, west of 40°W) and force 3 to 4 south of 40°N (south of 35°N, west of 40°W).

GALES (force 8 or higher) tend to decrease in strength and frequency during the latter half of March. On the average, gale-force winds have been noted in 10 percent of the ship observations north of a line extending roughly from Cape Hatteras to the Bay of Biscay, excluding the southern Norwegian Sea, the waters south of western Iceland down to 60°N, the seas west of southern Ireland to about 33°W, and the waters east of Newfoundland. A small area of gale frequencies greater than 10 percent covers the Gulf of Lions. The maximum frequency of gale occurrence, 20 percent, may be expected from the southern tip of Greenland south to about 55°N and between 40° and 50°W.

EXTRATROPICAL CYCLONES. Principal storm tracks head from the Great Lakes and the Carolina coast to Newfoundland. From Newfoundland, a primary track curves northward to the west coast of southern Greenland, and another track runs northeastward to Iceland and then into the Barents Sea. Over the Mediterranean area, a primary track extends from the Bay of Biscay east-southeastward to the southern Turkish coast.

TROPICAL CYCLONES. Only one tropical storm, a hurricane in the Lesser Antilles in 1908, has been reported in the North Atlantic in the past 104 yr.

SEA HEIGHTS of 12 ft or more are encountered more than 10 percent of the time north of a line from about 150 mi east of Cape Hatteras to Brest, France; in a small area northwest of Barranquilla, Colombia; in the Strait of Otranto between Italy and Albania; and from the coast of Sardinia northwestward to France. A large irregularly shaped area of 20-percent frequency lies in the open ocean bounded roughly by the following coordinates: 60°N, 55°W; 68°N, 25°W; 60°N, 10°W; 43°N, 43°W. Smaller areas of 20-percent frequency lie northeast of Bermuda, west of central Norway, and in the Gulf of Lions.

VISIBILITY less than 2 mi occurs 10 percent or more of the time over a 400-mi-wide elliptically shaped area extending northeast-southwest from 55°N, 40°W to 42°N, 58°W; over an area of the Labrador Sea from Cape Mercy to Cod Island; over the North Sea from southern Norway southeastward to Denmark and Sweden; and north of a line extending from southern Greenland to north of Iceland and then to the Barents Sea.

NORTH PACIFIC, MARCH

WEATHER. March is normally considered one of the transitional months between winter and spring over the North Pacific. Compared to the North Atlantic, weather improvement is somehwat delayed by the vast expanse of the ocean and the lingering winter climate over Siberia. Stormy weather is about as frequent as in the preceding month along the northern routes, especially from the western Aleutians southwestward to the vicinity of Japan. The 1005-mb Aleutian Low lies about 250 mi south of the Komandorskiye Islands and the Pacific High (1022 mb) rests near 33°N, 144°W.

WINDS. From about 40° to 60°N, winds from the westerly quarter are most frequent, although winds are variable north of the Aleutians and easterly over the Gulf of Alaska. In 40 to more than 60 percent of the observations, the wind force is 4 to 6. However, near the North American coast the most frequent wind speeds are force 4 to 5. West to north winds are most prevalent in Japanese waters south of 40°N where more than 50 percent of all winds vary between force 4 and 6. During March, the northeast monsoon continues to prevail along the Asiatic coast south of Shanghai and over Philippine waters. From 25° to 40°N, wind directions are variable, and the force is from 3 to 5 more than 50 percent of the time. The "northeast trades" are the dominant winds from 25°N to the Equator and extend northward to about 30°N over the eastern part of the ocean. The usual wind speeds, force 3 to 5, persist more than 60 percent of the time over the ocean area under the influence fo the trades. Northerly force 2 to 3 winds blow 40 percent of the time over the Mexican waters out from the Gulf of Tehuantepec.

GALES. In the central and western North Pacific, gales may be expected as far south as 30°N. In this area, north of 35°N and west of 175°W, 10 to more than 20 percent of ship reports contain winds of force 8 or higher. Over the eastern part of the ocean east of 175°W, there is a large reduction in gale frequencies compared to February, and occurrences are generally confined to latitudes north of 35°N. Percentage frequencies of gales in the central Gulf of Alaska, 10 to 20 percent in the preceding month, drop to 5 to 10 percent during March. Gales over the Gulf of Tehuantepec may be expected more than 5 percent but less than 10 percent of the time.

EXTRATROPICAL CYCLONES. The greatest frequency of cyclogenesis in the Northern Hemisphere takes place in the area off the Ryukyus in March. These storms run northeastward to an area about 250 mi east of Hokkaido where they join another primary track coming from La Perouse Strait between Sakhalin and Hokkaido. East of Hokkaido, the primary paths head northeastward to the western Aleutians where they either continue into the eastern Bering Sea or curve to the east-northeast and parallel the Aleutians and Alaska Peninsula until reaching the Gulf of Alaska. Another track extends from 50°N, 160°W, to the Gulf of Alaska. A storm track heads east-southeastward from the Gulf of Alaska to the Alaska Panhandle.

TROPICAL CYCLONES are infrequent during March. A tropical storm can be looked for once every 2 yr over the western ocean. Half of these tropical storms develop further into typhoons. Tropical cyclones during March usually sprout up east of the central and southern Philippines and west of 170°W.

SEA HEIGHTS of at least 12 ft occur more than 10 percent of the time in a somewhat rectangular area bounded approximately by 50° and 33°N, and 155°E and 140°W.

VISIBILITY. The southern limit of 10-percent frequency of low visibility (less than 2 mi) extends from Mys Alevina, Siberia, southward to 42°N, 160°E, and then northeastward to west of Kodiak Island. This frequency increases to more than 20 percent from the waters around the northern Kurils northeastward to the Komandorskiye Islands and then northwestward to Mys Ozernoy.

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NOAA National Weather Service Port Meteorological Offices have personnel who visit ships in port to check and calibrate barometers and other meteorological instruments. In addition, port meteorologists assist masters and mates with problems regarding weather observations, preparation of weather maps, and forecasts. Meteorological manuals, forms, and some instruments are also provided.

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